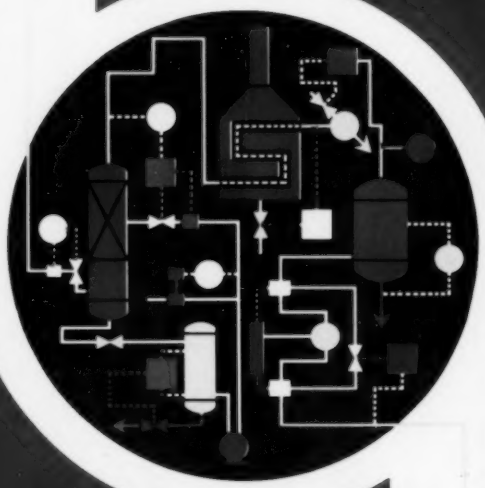
AUTOMATION

SEPTEMBER 1957



Instrumentation and Control

The Magazine of Automatic Operations

- Flow Measuring Devices
- Continuous Control of Viscosity
- Electropneumatic Control
- Optimal Control

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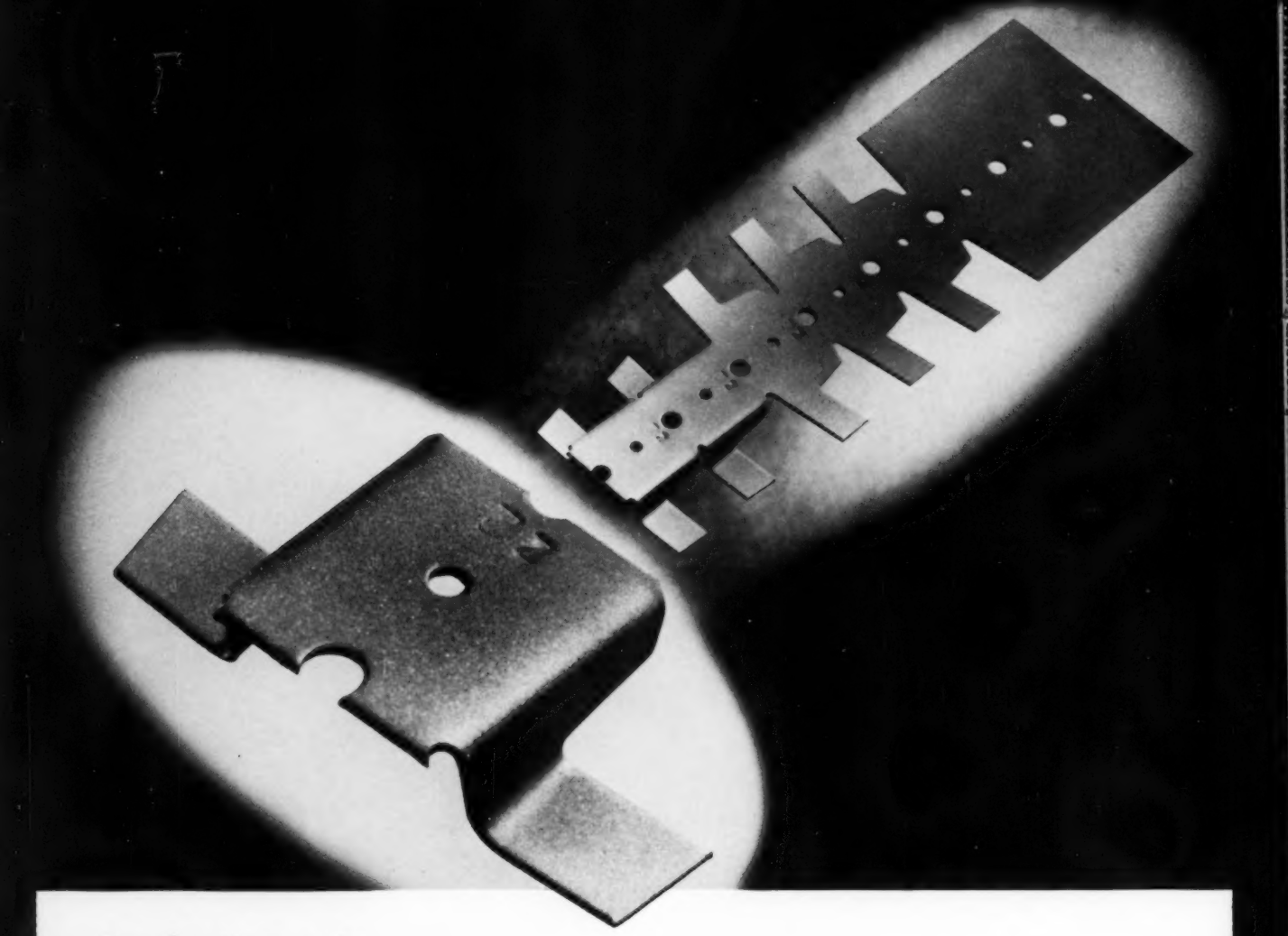

Production rate increased 400% on progressive forming

Production Rate: **Conventional Press — 75 pieces per minute**
Wean "Flying-Press" — 300 pieces per minute

This small progressive forming is called a keeper plate. It is stamped and formed out of .035 gauge strip steel. Length of index is 3". This part was produced on a conventional press at the rate of 75 per minute. Using the same dies, a Wean "Flying-Press" increased production to 300 parts per minute.

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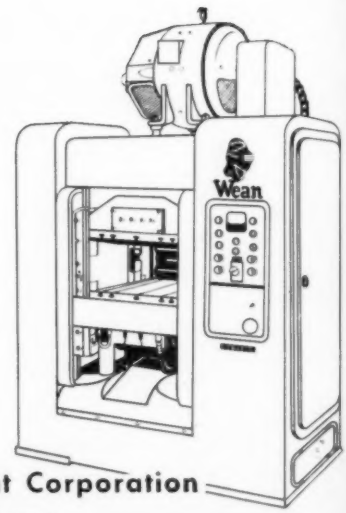
But why not get the complete story by writing today for your copy of the "Flying-Press" Brochure.



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The line designed for extra long life. Lab tests indicate life of Silvermodels and Whitemodels: 25 million cycles; Goldmodels and Bluemodels: 40 million cycles.

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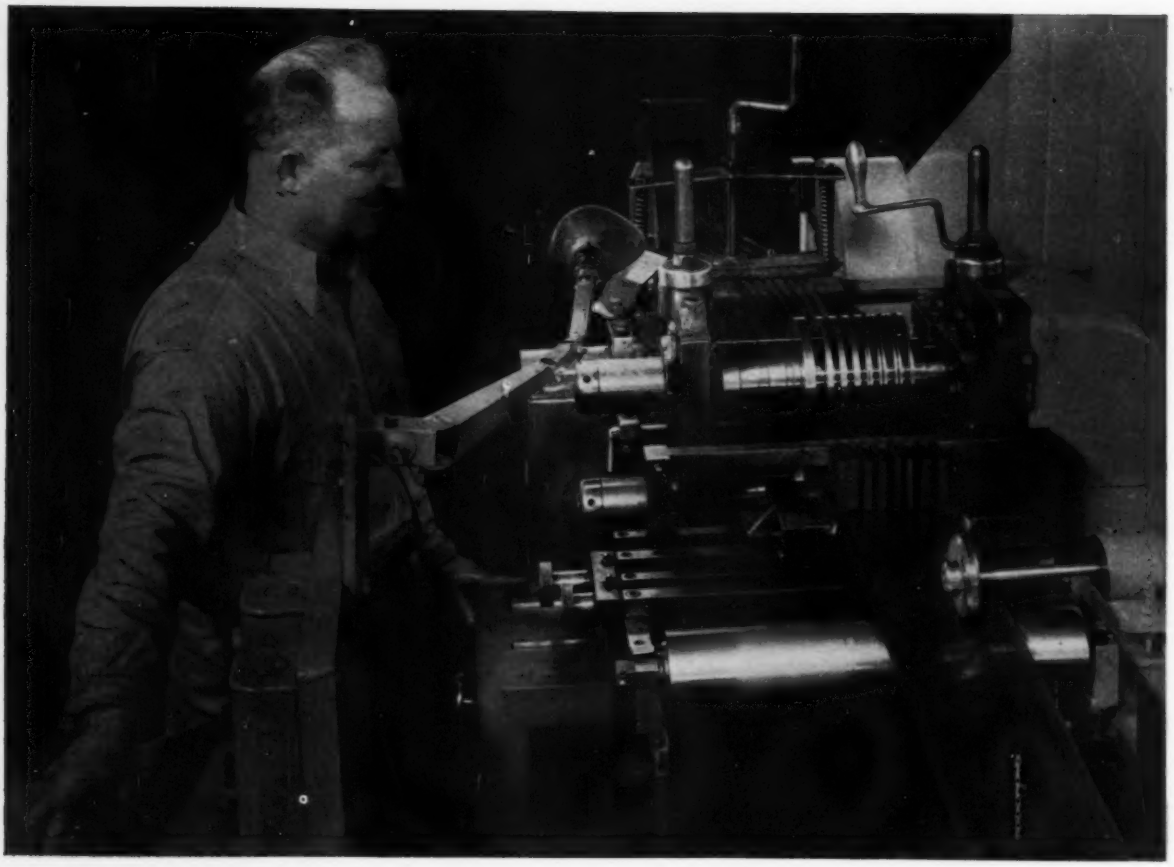

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Tinnerman Products, Inc., Cleveland, Ohio, produces more than 10,000 different shapes and sizes of "SPEED NUT" brand fasteners for industry... many of them to special specifications.

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SEPTEMBER 1957
Vol. 4—No. 9

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

SHOES DRAGGING

". . . let us also ask ourselves, 'Are our factories so managed as to encourage the integration of more automatic equipment?' . . . Whatever automation can come to the shoe industry can come only if we, ourselves, increase our own efficiency to permit whatever degree of automation is possible . . . I maintain that we should re-examine our own thinking and methods, many of which have made it difficult to effect such automation as is possible in our industry . . ."—*Charles Slosberg, Green Shoe Mfg. Co.*

MANAGEMENT'S ROLE

". . . I would like to emphasize the sometimes overlooked significance of the attitude and role of business and management in the practical realization of industrial automation. To automate is not the responsibility of one department of the business. It must be recognized that a practical automation program embraces all the functions of a business and not just the techniques of manufacturing. It must be recognized that a successful automation program is accomplished only through a step-by-step analysis of a company's products from a financial, marketing, and engineering viewpoint. This results in simplification and standardization —the two keys to the successful application of automation in the factory. . ."—*E. W. Denison, manager, manufacturing engineering, production engine dept., AGT Div., General Electric Co.*

BENEFITS OF AUTOMATION

". . . the results of automation have benefited production, the employee, the customers and also earnings . . . Production has been increased approximately 25 per cent by this program and as we continue, it is hoped we can increase this figure by further improvement. The employee has benefited by the elimination of tedious duties, as well as hopes for further expansion which will in turn lead to the opening of new jobs. The customer has benefited by increased production capabilities and our ability to handle larger runs and rush orders. This has made it possible to meet deadlines and decrease inventory of stock at their plants. They have also gained by better quality, as automation has improved this factor considerably. . ."—*Nicholas Marchak, director of research and engineering, Sun Tube Corp.*

TAXES LIMIT JOBS

". . . the greatest danger to a high level of employment is not automation, but heavy taxation, which removes from industry the funds with which to expand and create new jobs for the increasing population. . ." —*Gen. Douglas MacArthur, chairman of the board, Sperry Rand Corp.*

REPLACEMENT CRITERIA

". . . There can be only a limited class of work for which it is worthwhile to keep plant until it is finally worn out. Except for operations of the lowest engineering standard it generally pays to replace a machine long before it is physically exhausted. The economic life of plant may be determined by the rising costs of maintenance and overhauls, by improvements in the design of new machines, or by changes in manufacturing methods. As a result of the progressive development of new materials and new techniques, the economic life of plant in the larger mass-production factories is steadily diminishing. . ."—*C. W. Griffiths, chartered accountant, Joseph Lucas Industries Ltd.,* *see page 155.*

AUTOMATION

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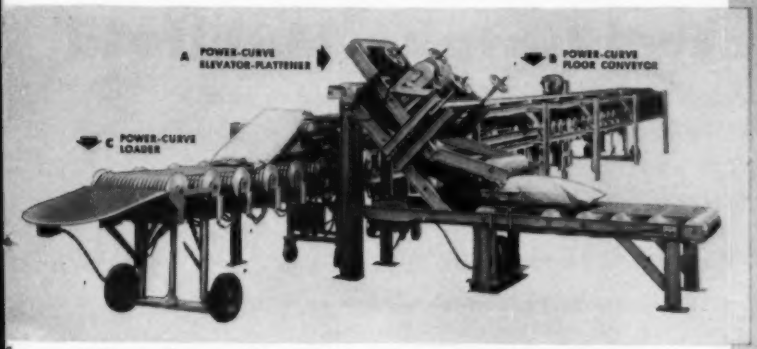

Delivered complete and ready to bolt down and start up.

a Bags fall from packer onto *Power-Curve* Elevator-Flattener and transfer onto Unit B to travel left or right. Elevators made to any length or incline angle.

b This Floor Conveyor, curved to by-pass obstructions, is instantly reversible—discharges bags to either truck or boxcar side of building. Loader is stored beneath it.

c Self-propelled loader has controls at each end. Conveys bags right up to stacking point, in end of trucks or boxcars. Shuttles beneath Unit B. Same loader delivers to storage area.

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ALL your bag handling...

Power-Curve supplies steady flow—eliminates all hand labor, wheel or lift trucking, costly empty "deadheading" between packer and stacking point on truck or boxcar. Adjustable delivery height at discharge end permits bags to be dropped in place. Men no longer lift or lug bags—easier work-load—high speed stacking. *One man with Power-Curve loads up to 15 bags per minute (45 tons per hour).*

Power-Curve has the answer to every step in your bag handling requirements. Complete systems come assembled and wired, ready to operate—no lost time for installation.

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  (Chutes or gate openings at any point)
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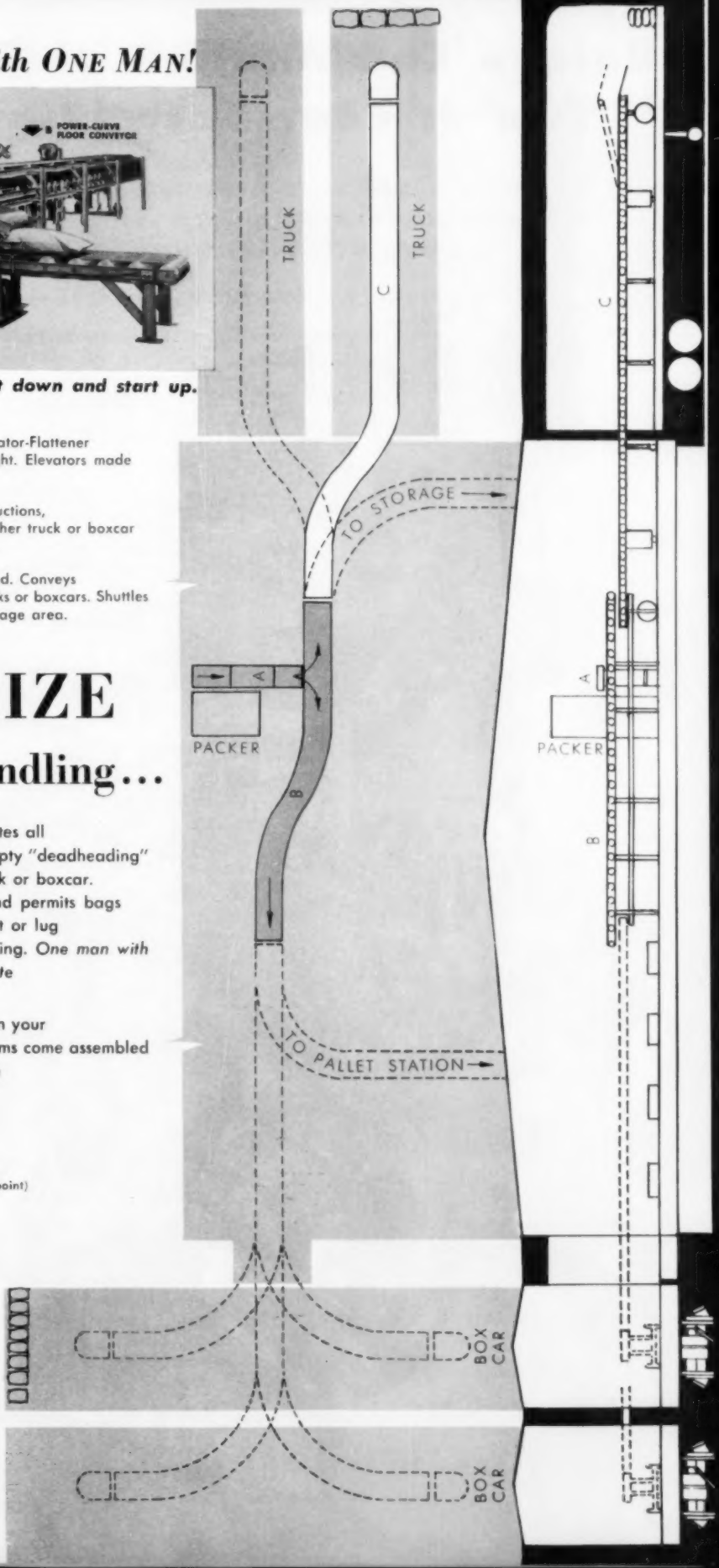

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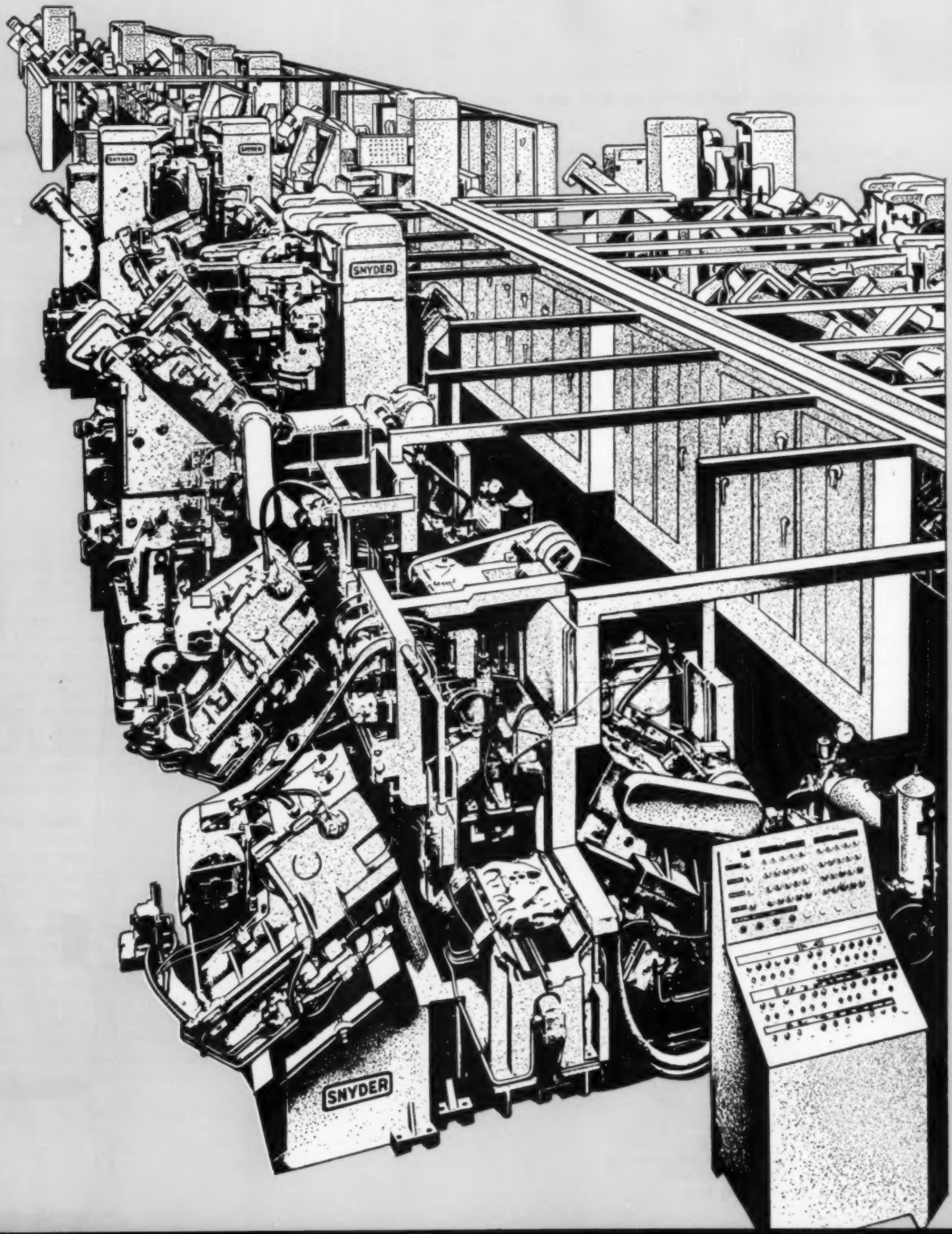

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Combination of two special transfer milling machines in parallel, with automation, feeding into one special transfer drilling machine gives production of 136 pieces per hour

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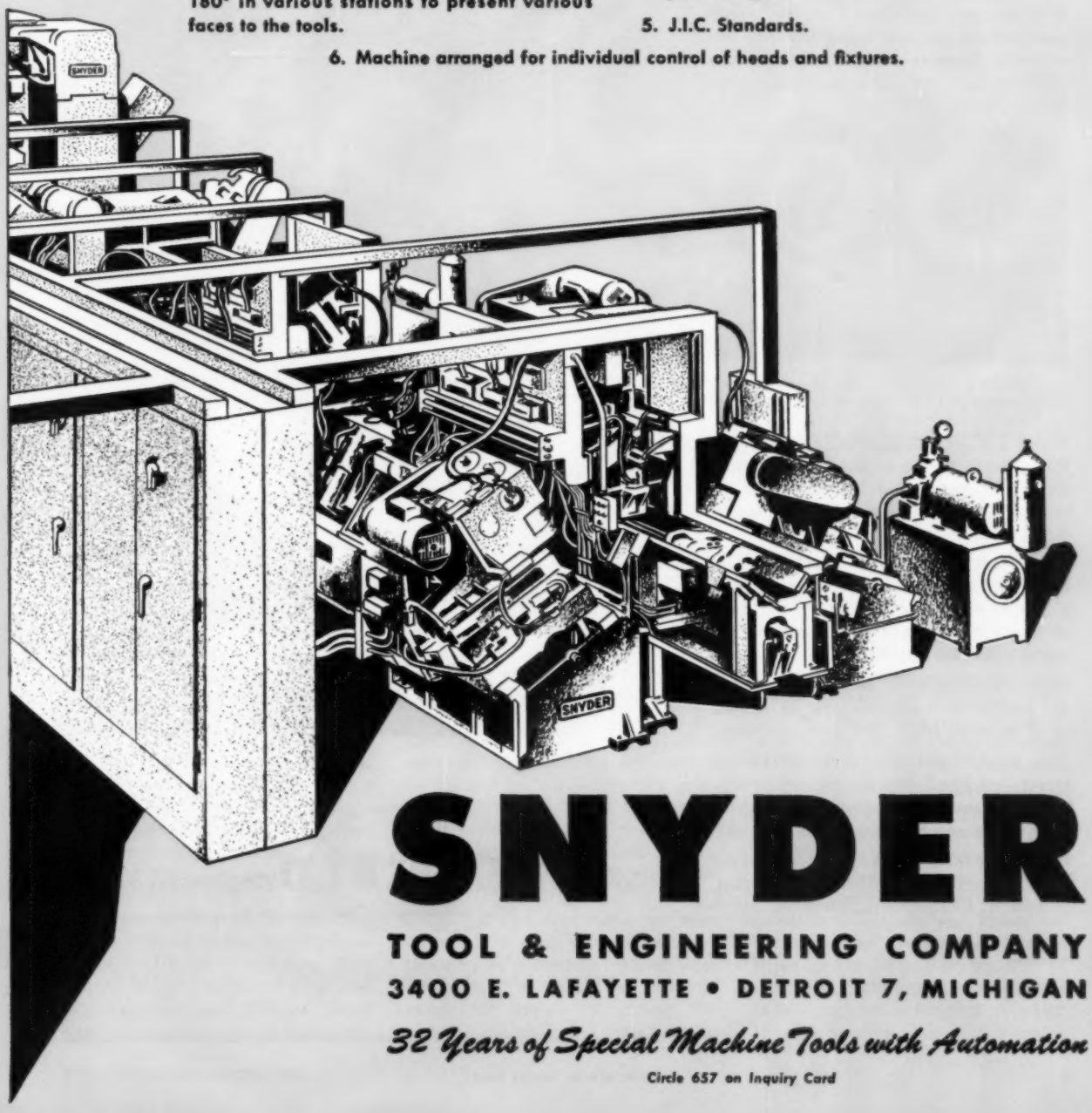
5. J.I.C. Standards.
6. Machine arranged for individual control of heads and fixtures.



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32 Years of Special Machine Tools with Automation

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A NEW AID FOR COST-CONSCIOUS MANAGEMENT

You can now determine just how much productivity you are losing because one or more elements of the operating cycle of an automated machine are not perfectly timed.

Now you can spot any timing error to within a 60th of a second immediately.

Cycle Analysis

Sheffield's new Monitorecord* system analyzes timing by means of a printed, composite time graph. This shows every start, dwell and stop of each interrelated event in the complex machine cycle – just as it occurs.

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When a Coded Master is laid over the time graph you see just what adjustments are needed and the amount of each. No tedious groping – no costly down-time.

What could serve Preventive Maintenance more effectively than taking such a graph every day? What could save as much set-up time? This system often justifies its cost the first time it is used.

System installation is no problem. It can be applied to machines now in service or it may be built into new machines.

The readily portable Monitorecord is merely plugged into the system receptacle of any machine requiring cycle analysis. It can be moved about at will.

Get all the facts on this profit-conserving idea. Write to the *Sheffield Corporation, Dayton 1, Ohio, U.S.A., Dept. 3.*

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AUTOMATION news

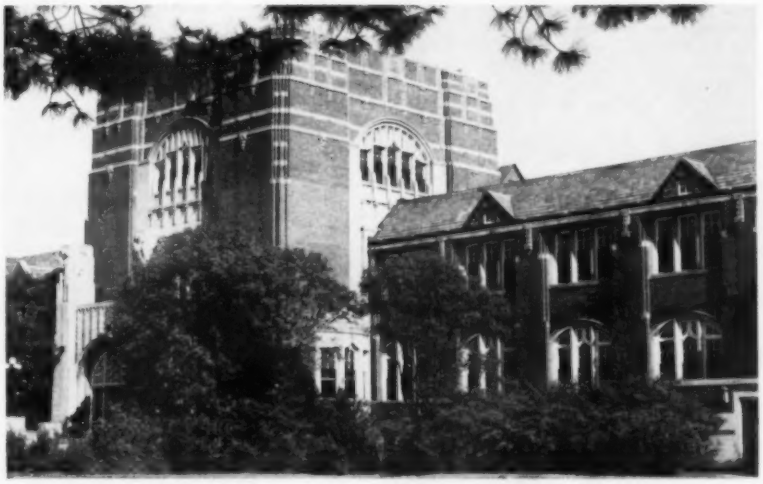
Today's events and developments in the field of automation

Simplified System for Control Panel Troubleshooting

NEW system that facilitates trouble-shooting of complicated electrical control panels on special machine tools with automation has been developed by Snyder Tool & Engineering Co. Called the Snyder Circuit Sleuth System, it can be applied to electrical control panels on a wide variety of automated machine tools including transfer machines, center-column machines, rotary index machines, trunnion machines and line-index machines.

Basically the system consists of terminal strips in the control panel to which all internal component connections are wired, and special pilot lights in the machine control panel. A typical pilot light panel for a Circuit Sleuth system would include lights for *Station, Clamp, Unclamp, Heads Back, Full Depth, Oil-mist Lubrication, Motor Overload, Central Pressure Lubrication,* and *Index Sequence.*

To find the trouble after a machine stops, the maintenance electrician looks at the light panel to determine the machine location and operation where the trouble exists. Then he goes to the control panel for the machine segment and operation. Each terminal on the Circuit Sleuth terminal strip is numbered in accordance with a wiring diagram that is supplied in a handy reduced size with the system. First the overall circuit is checked with a bell or light set. Then a detail check of each electrical component in the system is made by checking from numbered to numbered terminal on the Circuit Sleuth strip. The system is extremely compact and cuts machine tool control panel troubleshooting time to a minimum.



SCENE of the Second Conference on Manufacturing Automation at Purdue University to be held on October 7, 8 and 9. This structure, the Memorial Union Building, provides excellent facilities for the formal and informal sessions and also includes dining facilities and guest rooms. Theme of the conference is *Engineering the Automated Line.* Twelve top authorities will discuss some of the most pertinent aspects of this subject.

Second Manufacturing Automation Conference Attracts Top Automation Talent

PURDUE'S Schools of Mechanical and Industrial Engineering and the editors of AUTOMATION Magazine have assembled a group of top authorities for the Second Conference on Manufacturing Automation to be held on the University campus October 7, 8 and 9. From various backgrounds and wide experience these men represent an outstanding wealth of knowledge in automatic operations.

This second conference has been developed mainly around basic interests and questions evolved from the first conference. A carefully integrated series of papers designed to establish some fundamental considerations and basic "how-to" for engineering the automated line will be presented. Here will be authorities on phases of automation applicable to all types of manufacturing and processing industries. Specific questions from the floor will tap this reservoir of technical and management know-how of automation. Two afternoon round table sessions are designed to permit informal man-to-man discussions of specific and varied aspects of the field impossible to cover in the formal program.

Special highlight of the program is the conference banquet at which the Honorable Wright Patman,

chairman of recent Congressional committee hearings on automation, is the speaker.

Conference Speakers

Richard Muther, executive director, Richard Muther and Associates, Kansas City, Mo. The first presentation of the conference is concerned with the basic economic and practical thinking underlying the evolution of automatic line production. To present the paper, "Planning Automatic Line Production," Muther will draw upon an extensive background that has earned him a reputation as an internationally recognized authority in the field of plant layout and factory planning. He has taught at MIT, at Robert College, Istanbul, Turkey and at the U. S. Navy Management and Industrial Engineering School. In addition to management consultant work in this country, Muther has acted as consultant to firms in France, Sweden and Switzerland. He is a registered professional engineer in Ohio and Missouri and currently a national director of the Society for Advancement of Management.

George E. Wralstad, manager, Plant Facilities and Maintenance, Small Integral Motor Dept., General Electric Co., Ft. Wayne, Ind. A case study of a recently developed automatic line can serve as a useful and practical base upon which to build a discussion of the many factors which are necessary for a successful operation. With over 12 years experience with G.E., including 2 years as supervisor of plant engineering for the General Purpose Motor Dept. and 2 years in his present position, Wralstad is eminently qualified to discuss in a paper entitled "Developing the Integrated Line" the many details which resulted in the successful development of a line for production of small motors. Of particular interest to the metalworking field, the paper discusses the use of presses within an integrated line.

Robert G. Dexter, treasurer and chief engineer, Barkley & Dexter, Inc., Fitchburg, Mass. Unusual ability in analysis of methods and operations, evidenced by wide experience on practical mechanical and electromechanical devices which have been essential in automation of many industrial operations, provides Dexter with broad background for his paper, "Estimating Special Equipment Costs." He has been an aircraft designer for several air frame manufacturers, and prior to the formation of Barkley and Dexter was a consultant. Present duties include responsibility for one million dollar a year expenditures in development, prototype and production equipment costs. Dexter is a registered professional engineer in the state of Massachusetts and a member of the American Society of Mechanical Engineers.

Joseph G. Adiletta, assistant manager, Electronics Laboratory, American Machine and Foundry Co., Greenwich, Conn. Companies without extensive experience in developing and building new machines should gain increased understanding of the different costing techniques involved in bringing out specialized and standardized machines. Adiletta, whose paper is entitled "Comparing Machine Cost and Time Factors," has had broad experience in the administrative phases of engineering. In his present position he administers radar, missile, telemetering, navigations and communications research and development contracts and is responsible for development of new nuclear products, automatic machine controls and electronic products. A professional engineer in Connecticut and New York, he is presently a candidate for a Ph.D degree in Engineering Science from New York University.

Robert W. MacWilliams, supervisor of engineering, Management Services Div., Ernst & Ernst, Boston. "How to Figure Payoff" is the title of the paper to be discussed by MacWilliams. Experience indicates that savings in direct labor costs are but one of the factors which management must consider in establishing a realistic payoff period. Analysis must include materials savings, machine utilization, reduced waste, etc. Payoff periods for automated installations vary widely. MacWilliams held a number of engineering positions before assuming his present position in 1954. He is a past president, Boston Chapter, Society for Advancement of Management.

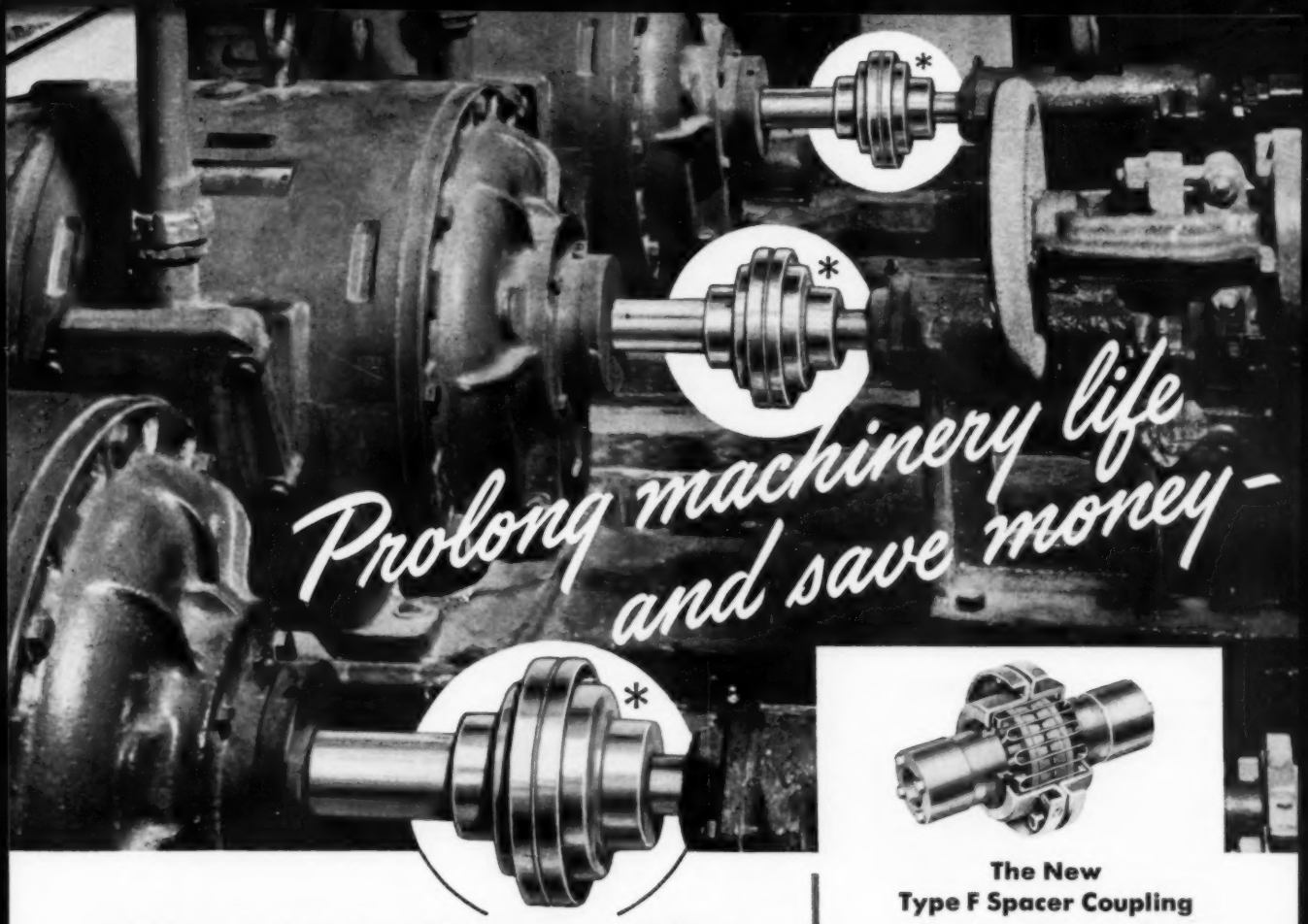
John F. Anderson, manager of production engineering, Engine Div., Chrysler Corp., Detroit. Every available gaging device must be considered in achieving the optimum control of automatic operations. In a paper entitled, "Gaging Control," Anderson, a registered professional engineer, will discuss dimensional gaging as well as basic methods in general, integration of gaging devices into an automatic line, feedback, and quality control. During his 11 years with Chrysler, Anderson has progressed from co-operative engineering student through various tool engineering assignments to his present position where he is responsible for those departments engaged in cost estimating; time standards and methods analysis; processing; process development; project analysis; plant engineering; quality control; and casting and forging engineering.

Albert F. Sperry, president, Panellit Inc., Skokie, Ill. As one of the founders of the Instrument Society of America and its first president, Sperry can speak with authority on the importance of "Process Control." He is one of the country's experts on automatic control and industrial processing and has been active in original design, development and application for many years. In prewar years Sperry organized the Hubbard Engineering Co.; during World War II he served as an engineering expert for the Atomic Energy Commission, Air Corps and Signal Corps in addition to assisting in organization of the Instrument Advisory Committee for the U. S. Army Industrial College. Following the war he organized Panellit, Inc. and pioneered in the design and manufacture of central control and data reduction systems. Sperry is a registered professional engineer in several states, holds many patents, and has been honored by the American Society of Mechanical Engineers as well as the ISA.

Glenn R. Petersen, manager, Program Control Sales, Specialty Control Dept. General Electric Co., Waynesboro, Va. The subject to be discussed by Petersen is "Numerical Control," one of the most promising of new developments in the automation field. The General Electric Co. has been closely associated with developments in this area and is one of the few companies whose experience embraces a wide variety of types of numerically controlled equipment. Prior to assuming his present position, which includes responsibility for the marketing of automatic tracer controls, numerical contouring controls and numerical positioning controls, Petersen was engaged in the sales of specialized gaging and processing equipment, particularly those types using x-rays or radioactive source material.

Congressman Wright Patman, Texas. In view of the widespread national interest in automation which followed the introduction of the word into the average American's vocabulary, the legislative branch of the government undertook the investigation of the national significance of the technology. The investigation was conducted by the Joint House and Senate Committee on the Economic Report through its Sub-Committee on Economic Stabilization. Congressman Patman is chairman of both committees. The comprehensive investigation of the national aspects of automation serves as a background for Congressman Patman's talk, Automation In The National Eye. During his 29 years tenure as a Member of Congress, he has been closely associated with committee work devoted to business and finance matters and has sponsored a number of bills concerned with business problems.

Jervis C. Webb, president and general manager, Jervis B. Webb Co., Detroit. Drawing upon his 20 years experience in the mechanical handling field, Webb will discuss "Automatically Handling Parts In Process" with emphasis on handling problems associated with bulky or odd-shaped large parts. He has authored numerous articles on materials handling; and presented papers on the subject before various engineering and technical societies. Among the organizations to which he belongs are: Young President's Organization, ASME (chairman, Material Handling Div. for 1957), Materials Handling Institute and American Materials Handling Society.



Prolong machinery life and save money-

with FALK Steelflex Couplings

Ever since the first Falk Steelflex Coupling was designed and built, we have firmly held to these beliefs:

1. A coupling, to give fullest value, must do more than merely *connect* driving and driven machinery—it must *protect* the machinery and prolong its life.

2. A coupling, to be truly flexible, must overcome the effects of shock and vibration, as well as shaft misalignment.

Proof of the soundness of those beliefs is furnished by the record. More than one million Falk Steelflex Couplings have been used on every conceivable type of industrial application . . . giving trouble-free service, providing maximum protection to connected machinery.

* A single basic type—the famous Type F—fills 90% of all industrial application needs. It is versatile, efficient and economical. And—it is always available from factory, field or distributor stocks, in a wide range of sizes.

Write to Department 247 for engineering bulletin, including selection and dimension tables.

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

MANUFACTURERS OF:

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

...a good name in industry

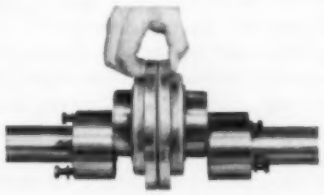
Circle 659 on Inquiry Card

The New Type F Spacer Coupling

Here is a Steelflex coupling specially designed to permit fast, easy installation and removal in horizontal and vertical applications where it is impracticable to move the connected units—or where a space-gap (up to 12 in.) is necessary.

Like all Steelflex couplings, the Type F Spacer gives long, trouble-free service and maximum 3-way protection for connected machinery: it provides torsional resilience to reduce shock and vibration; it accommodates parallel or angular shaft misalignment; it allows free (or limited) end float.

An outstanding feature of the Steelflex Spacer is that it can be installed or removed in one piece (see photo below); no dismantling or servicing of the coupling is required. Pump assemblies can be disconnected and removed without disassembling the coupling, without exposing working parts.



The Steelflex Spacer coupling is prelubricated at the Factory and can be installed, or removed and reinstalled, without disturbing the lubricant—a highly desirable feature.

E. Gordon Reader, vice-president and general manager, Ferguson Machine Corp. of Indiana, St. Louis, Mo. The general assembly problem of handling small or intricate parts will be covered in Reader's paper, "Orienting and Placing Small Parts for Assembly." He served on the staff of C. N. Neklutin, vice-president of engineering, Universal Match Corp. prior to joining Ferguson Machine and Tool Co., a subsidiary of Universal Match. In this latter company he has been concerned with automatic assembly machines from the outset. Appointed to his present position in 1955, Reader has guided the firm into the field of automatic tooling. One plant of his firm manufactures roller gear drives, index tables and transfer machines; the other plant specializes in automatic tooling, feeding and placing mechanisms and the building of complete automatic assembly machines.

Kenneth R. Treer, vice-president, Gray Equipment Co., Lakewood, Ohio. With his paper entitled "Economics of Automatic Assembly," Treer will discuss a subject that is one of the most difficult yet most rewarding in the area of automation. Readers of **AUTOMATION** will recognize Treer as the author of several articles on automatic assembly which have appeared in this magazine. The articles were based upon his experience in dealing with automatic assembly equipment. Earlier experience includes several industrial engineering assignments and an association with a firm specializing in automatic finishing equipment. Treer is an aviation enthusiast, holding both commercial and flight instructor ratings.

Work Contact Unnecessary With Vibration Measurement Device

INSTRUMENT for measuring displacement, runout or vibration of mechanical parts without physical contact with the part has been developed by Optron Corp. The tripod mounted instrument is an optical device containing elements which follow the motion of a spot of light in making its measurements. An intense spot of light is sharply focused by a lens onto the edge of a moving object. Reflected light from this projected spot is picked up by a photocell. A servoamplifier in the photocell circuit oscillates the spot at the same rate as the object being measured in attempting to correct an unbalanced circuit condition. The signal from the servoamplifier which drives the spot is sampled and applied to an oscilloscope. Thus the spot on the oscilloscope exactly follows the motion of the projected spot. By synchronizing the sweep, the oscilloscope will present the exact waveshape of the motion itself to show all transients and characteristics of the displacement.

The unit may be used to measure the amplitude and frequency of shake tables, vibration testers, accelerometers, and relay contacts, or measure runout of rotating shafts, cylinders, flywheels, or any part without making contact while the work is in motion.

ISA Committee Organized To Study Pipe Line Problems

FOR effective solution of the instrument and control problems facing the petroleum and gas pipe line industries, a Pipe Line Committee of the Instrument Society of America has been organized to co-operate with pipe line companies and control equipment manufacturers. Vice chairmen in charge of organizing the activity are **I. W. Schmitt,** El Paso Natural Gas Co., and **M. T. Nigh,** Service Pipe Line Co.

It is planned to establish a priority list of subjects for study and action. Acting as co-ordinating agencies, two subcommittees—one devoted to petroleum and the other gas—will bring together those concerned with problems of measurement, telemetering, control, testing and operation of pipe lines. It is hoped to promote greater use of dynamic analysis of complete pipe line systems as a means for better solving control problems. Persons interested in serving on these committees are invited to write to **T. C. Schroeder,** Chairman of the ISA Transportation Committee, at Union Switch and Signal Co., Swissdale, Pa.

ANNOUNCEMENT has been made of the appointment of **C. E. Huddleston** as director of engineering at the Lewis Welding & Engineering Corp. by **J. T. Lewis, Jr.,** president. In his new capacity, Huddleston will have broad responsibility for the integration of the company's plan for expansion into the field of creative design and building of specialized machinery and equipment. The company is presently known as a manufacturer of arc-welded products as well as a builder of heavy industrial equipment.

New Foil Type Strain Gage Superior To Bonded Wire Type

IMPROVED foil type strain gages have been developed by Baldwin-Lima-Hamilton Corp. Previously, foil gages were inferior to bonded wire strain gages in performance at "room temperature" ranges, but foil gages were used to measure strains at temperatures of 1000F or higher. The new gage has proved itself at lower temperatures ranging to 300F for continuous duty and 400F for short-time measurements.

Because foil gages are thinner and more flexible, they are more easily applied than wire gages, especially in fillets, and have proved very useful for stress analysis work.

Measurements have shown that the hysteresis of the new foil gage is improved relative to comparable wire strain gages; the fatigue life of the gages is directly comparable to certain bonded wire gages; and although the longitudinal strain sensitivity of the new gages is 5 per cent greater than that of equivalent bonded wire gages, the lateral strain sensitivity is a great deal smaller, being between ⅓ and ½ that of comparable bonded-wire gages. A reduced lateral sensitivity permits single gage measurement under biaxial strain conditions with an accuracy greater than that obtainable from bonded-wire gages.

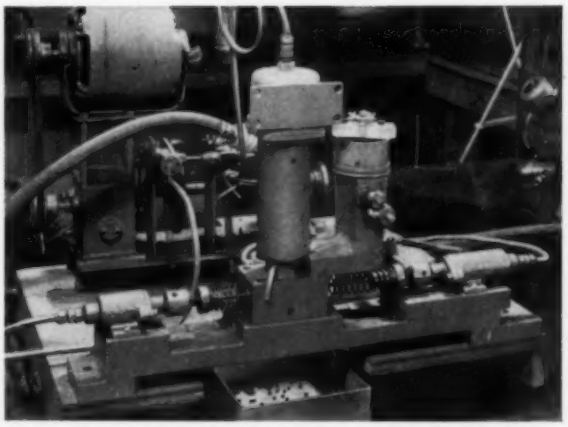
High Production On Short Runs With Sliding Bolster Presses

INCREASED production through a reduction in die changeover time is possible on a press design developed by Hamilton Div. of Baldwin-Lima-Hamilton Corp. The press was developed primarily for high production on short runs and uses sliding bolsters and preset dies. A similar design has pre-

***Progress** in designing air systems:*

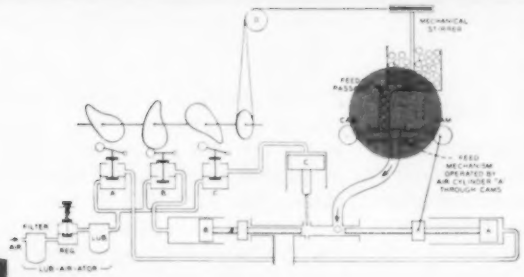
Here's another automating idea: Schrader Air Products in a multi-step punching system

PROBLEM: To pierce tiny balls of lead shot, fast, accurately, and economically.



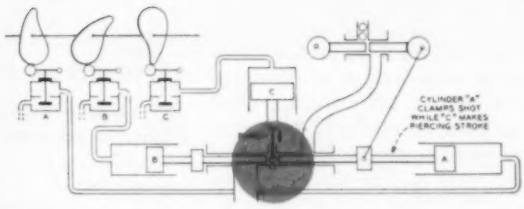
Schrader Products successfully performing at prominent Western plant—feeding, shot-piercing, ejecting—all automatically with air.

SOLUTION: Schrader Air Products designed into a system for automatic operation.



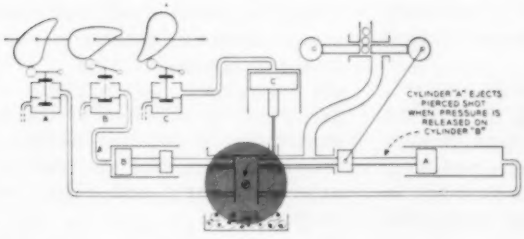
1

FEED: Performance of the cylinders in this system is controlled by cam-actuated Schrader valves. Cylinder A controls split-cam feed; allows the shot to be fed into the machine one at a time.



2

PIERCE: The shot is pushed forward and clamped at the piercing station by cylinder A and cylinder B. Cylinder C pierces the shot.



3

EJECT: Cylinder B returns to its initial position. Cylinder A completes its forward stroke, ejecting the pierced shot. And cycle starts again.

Air's benefits apply in almost any operation you can name: stamping, forming, programming, squeezing or measuring. And the advantages are more important today than ever: speed, accuracy, safety, simplicity, versatility, and—amazing economy. Schrader components are a natural for the designer because they comprise the only complete line of air products to select from. They can be used singly or in combination to perform jobs of amazing variety and complexity. When you design, think of air, and make use of Schrader's engineering facilities to help you specify the right products for your idea. Mail the coupon today.

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Circle 660 on Inquiry Card

viously been used by Hamilton for die spotting presses, but the sliding bolster is an advance for presses performing production operations such as blanking, drawing and forming.

The new design provides each press with two sliding bolsters, positioned by a motor drive in the press base. The units can also be powered by motor driven winches. The bolsters can travel through press sides rather than the fronts or backs—an important feature for a line of presses, particularly an automated line linked together by material handling devices.

The sliding bolster design has the following advantages: Increases production through decreased die changeover time; reduces die set-up time; affords high production for short runs with a minimum of press downtime for changing dies; reduces parts storage requirements; lowers cost in comparison to two presses that might be needed to perform the same amount of work; and eliminates the necessity of removing automation equipment when changing dies.

Radiation Gage Positions Ingot In Titanium Process Furnace

RADIATION, in the form of gamma rays from radioactive cobalt, is being employed by the Westinghouse Research Laboratories to detect and control the height of a titanium ingot being melted in an arc furnace. The furnace is designed to prepare purified titanium metal. In controlling the height of the titanium, the gamma rays pass through as much as 15 inches of solid metal.

The source of gamma rays, a small needle of cobalt-60 is placed outside the furnace and in line with the desired position of the surface of the ingot within the furnace. A shielded lead box having walls about four inches thick contains the cobalt-60. When a shutter in the box is opened, gamma rays pass through the furnace walls and across the top surface of the ingot. If the ingot is too high, it partly blocks the gamma rays, reducing the amount of radiation received on the other side of the furnace. If the ingot is too low, the amount of radiation passing through the furnace is greater.

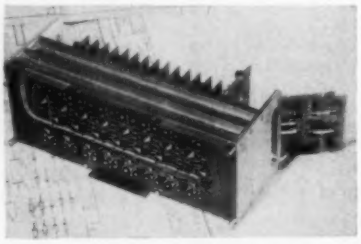
The amount of radiation is detected by means of two counters containing a crystal which changes the gamma rays into flashes of light. The equipment then converts the light flashes into electrical pulses and amplifies them. The amplified pulses are fed to electronic circuits which drive a hydraulic system that raises or lowers the titanium ingot to the exact position required for proper operation of the arc furnace. The system can detect and maintain the level of the titanium ingot to within 0.01 of an inch of its ideal operating position.

Computer for Process Control

TO ADVANCE automation in industrial process plants the Ramo-Wooldridge Corp. has announced the development of a fully transistorized digital control computer.

Designed to automatically control a wide variety of manufacturing processes, including paper manufacturing, metals processing, chemical manufacturing and oil refining the RW-300 provides the flexible, sophisticated computational and control ability necessary to implement integrated control systems.

When used as a central unit of a process control system, the RW-300 receives input data from process instruments, performs necessary computations to relate readings to process objectives, determines control actions that will result in optimum plant operation, and activates process mechanisms or adjusts set points on supervised control loops.



DIGITAL control computer RW-300 made by Ramo-Wooldridge Corp. is built on a modular basis with active circuits mounted on inserts attached to modules which are plugged into subframes that have printed circuits with dip soldered connections.

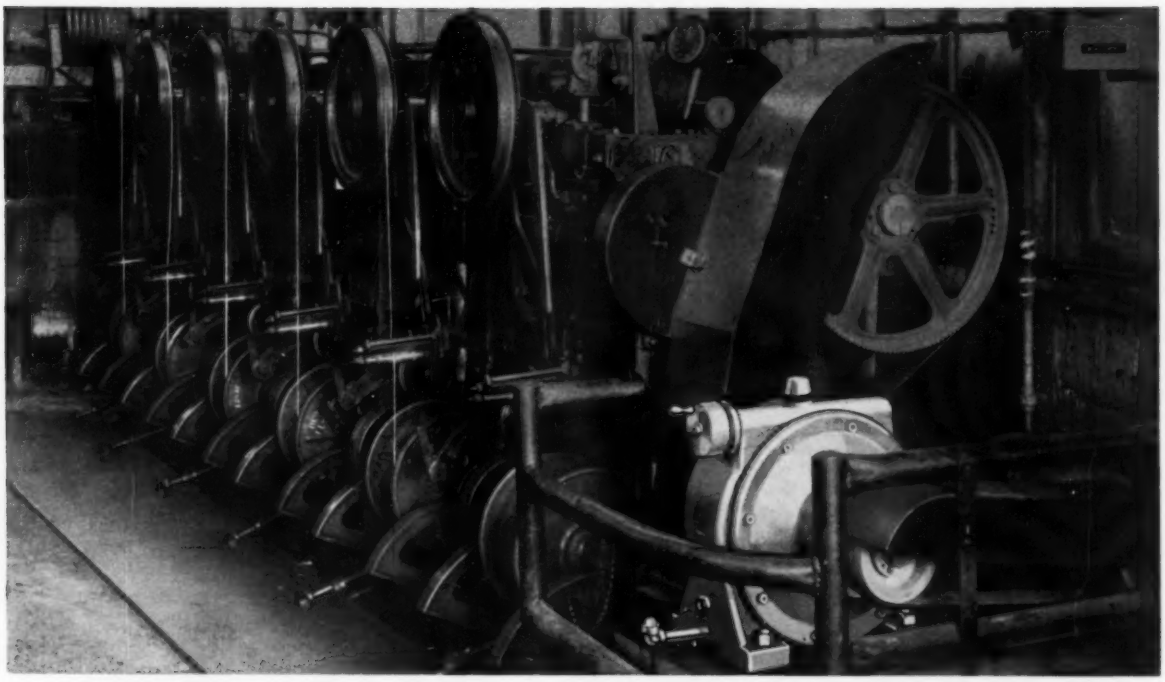
It carries out a number of functions in automatic on-line process control. In input data interpretation, it does scaling, linearizing and compensation for interferences. In computing, it can do maximizing, minimizing, averaging, correlating, smoothing, equation solving, interpolation, extrapolation, integration. In logical operations, it can start up or shut down a process unit, make comparison with standard conditions, and select material flow paths. In checking and alarm operations, it makes instrument checks, process stability checks and computer self checks. Data recording functions include process operation instructions and data logging.

When used as a data logger, the RW-300 converts measurements of process instruments into digits which are printed out to provide permanent records of process variables. The RW-300 provides the computational capability, flexibility, precision and speed of a general purpose digital computer which can not only record data but also interpret and manipulate it.

The computer has integral input-output buffering, selection, and analog-digital conversion equipment, allowing it to be connected directly to process instruments and control devices. It accepts inputs from practically any kind of process instrument. Input-output capacity can be adjusted to the requirements of different processes. Standard typewriter and punched paper tape input and output are provided.

Three-Dimension Radar Tracking

RADAR track-while-scan system, which automatically tracks up to 72 targets in three dimensions, has been developed by the Westinghouse Electric Corp.'s electronic division. The incorporation of three-dimensional information in the system, directly from a single radar source, is unique in the industry. Individual monitors for each track are provided and automatic track fault alarms permit



CLEVELAND SPEED VARIATOR

winds 4 reels of cable simultaneously—where old drive slipped with 2 reels

THIS machine winds tin-plated wire used in the manufacture of cable. The Cleveland Speed Variator on it replaced a drive of the same capacity with which there was slippage and frequent maintenance.

With the new Cleveland, it was immediately possible to run simultaneously 5 reels of the heaviest wires, as compared to only 2 with the old drive. In fact, the 10 HP drive motor soon proved unequal to the 5-reel load which the Cleveland was handling without slippage. Now driving 4 reels of the heavy wire, the machine is doing double the work it formerly handled.

Wherever you need a variable speed drive, consider Cleveland. Write for Bulletin K-200. The Cleveland Worm & Gear Company, Speed Variator Division, 3265 East 80th Street, Cleveland 4, Ohio.

Note these major advantages of the Cleveland Speed Variator

1 An extremely compact unit, with input and output shafts in line and rotating in the same direction.

2 Operable at any input speed up to 1800 rpm—either clockwise or counterclockwise rotation.

3 Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant torque over a 6:1 range.

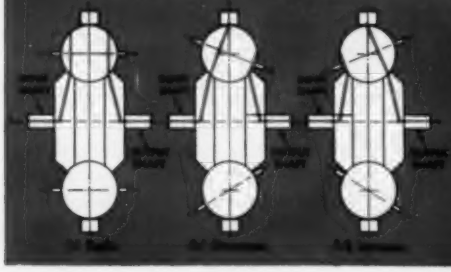
4 Infinitely variable output speeds over the entire range of adjustment.

5 No slippage—positive, automatic torque adjustment in direct proportion to the loads encountered.

6 Ample bearing support on both shafts for overhung pulleys.

7 Long life and minimum maintenance through absence of belts and complicated linkages.

HOW THE CLEVELAND SPEED VARIATOR WORKS



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

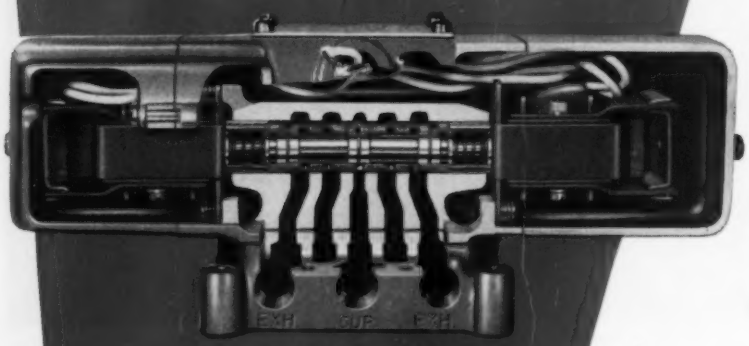
Relative speeds of the shafts are adjusted by changing the positioning of axles on which the balls rotate (diagram, right, shows cutaway Variator with hand regulating wheel).

"It's the Drive That's on the Ball."

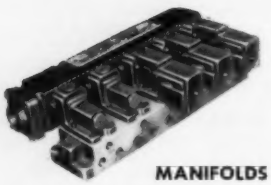
Circle 661 on Inquiry Card

Specify **NUMATICS VALVES**
. . . there are no "equivalents"

VARIETY



3-position air valves for unusual circuits



MANIFOLDS

DSA34 valves mount interchangeably with all other SA Series air valves on Numatics air and conduit manifolds.

LINE VALVES

Numatics makes a complete line of foot-mounted, line-mounted 2- and 3-way valves, too. Ask for Bulletin #4000.

Today's control demands, particularly in automation applications, require a host of unusual air circuits . . . emergency stop inching circuits, dumping both ends of cylinder to exhaust, pressurizing both cylinder ports, to mention a few. The valves for jobs like these? Numatics spring-centered DSA34 valves . . . the valve series that gives you split-second response, takes pressure surges without sticking or fluttering. Numatics DSA34 valves are offered, what's more, in a wider variety of sizes and actions than any similar valves now on the market. Want more details? Send for Numatics new Bulletin #558A on unusual circuits using 3-position valves.

●

NUMATICS, Inc.

HIGHLAND, MICHIGAN Dept. A

one operator to successfully monitor 12 tracks.

The equipment includes a hybrid digital-analog system in which error sensing is a completely analog function accomplished under the control of a digital device which computes, controls and displays information on all 72 tracks. Made up of package units using printed circuits and static components, the computer includes approximately 1500 transistors and 11,000 diodes in its various circuits. Magnetic elements are used where presently available transistors do not have the necessary power handling capabilities. The computer has been in operational test for about 10 months and excellent operation results are reported.

CONSTRUCTION paymaster located in trailer 1300 miles from home office watches as paychecks at rate of five a minute are printed by teletype machine. Home office accounting department does all computations based upon data transmitted daily from job site. The system is used by F. H. McGraw & Co. of Hartford and combines equipment furnished by AT&T and IBM in achieving economies of administrative operations in construction projects.

To Manufacture Rail Welder

EXCLUSIVE manufacturing rights to a Swiss machine that can weld standard railroad rails into one continuous quarter-mile length in less than two and one-quarter hours have been obtained by National Cylinder Gas Co. The equipment was developed by H. A. Schlatter AG, Swiss manufacturer of resistance welding machines. The Schlatter rail flash resistance butt welder can make 15 rail joint welds per hour at costs estimated

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starts on page 91 starts on page 123 starts on page 147

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418	448	478	508	538	568	598	628	658	688	718	748	778	808
419	449	479	509	539	569	599	629	659	689	719	749	779	809
420	450	480	510	540	570	600	630	660	690	720	750	780	810
421	451	481	511	541	571	601	631	661	691	721	751	781	811
422	452	482	512	542	572	602	632	662	692	722	752	782	812
423	453	483	513	543	573	603	633	663	693	723	753	783	813
424	454	484	514	544	574	604	634	664	694	724	754	784	814
425	455	485	515	545	575	605	635	665	695	725	755	785	815
426	456	486	516	546	576	606	636	666	696	726	756	786	816
427	457	487	517	547	577	607	637	667	697	727	757	787	817
428	458	488	518	548	578	608	638	668	698	728	758	788	818
429	459	489	519	549	579	609	639	669	699	729	759	789	819
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424	454	484	514	544	574	604	634	664	694	724	754	784	814
425	455	485	515	545	575	605	635	665	695	725	755	785	815
426	456	486	516	546	576	606	636	666	696	726	756	786	816
427	457	487	517	547	577	607	637	667	697	727	757	787	817
428	458	488	518	548	578	608	638	668	698	728	758	788	818
429	459	489	519	549	579	609	639	669	699	729	759	789	819
430	460	490	520	550	580	610	640	670	700	730	760	790	820

AUTOMATION SEPTEMBER 1957

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COMPANY

PRODUCT MANUFACTURED

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CITY ZONE

STATE

Do not use this card after November 15, 1957

AUTOMATION

Information Service

For your convenience, advertisements and items of information on new equipment, components and manufacturers' literature can be quickly identified by an *Item Number* accompanying each unit.

For additional free information circle item number on an inquiry card. Fill in your name, title, address, etc.—Drop it in the mail—No Postage Required—Your request will receive prompt attention and will be filled directly by the manufacturer.

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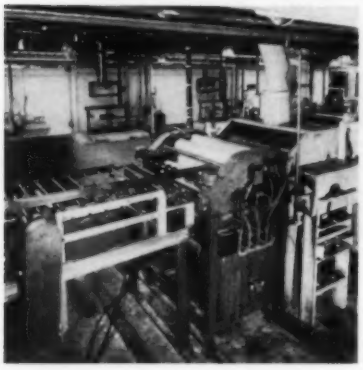
to be as low as half of those for conventional unwelded joints or joints prepared by other welding methods presently used.

The system—welder, diesel electric power unit and auxiliaries—occupies three full-size railway freight cars. In operation, the welder applies a maximum of electric current for a minimum of time to rail ends fitted firmly together in the machine. The resulting heating action is followed immediately by a hammer like impact of up to 60 tons upsetting pressure that provides a high quality weld not requiring subsequent annealing treatment as in other rail welding methods. In four minutes, rail sections can be placed in the machine and welded; weld burr sheared off automatically; and rails moved ready for the next joint.



PRODUCTION testing of the use of chemical coatings for metals is a service offered by Parker Rust Proof Co. It is anticipated that metal fabricators about to add a new product or to convert to automation will make use of the facilities rather than install pilot equipment in their own plant. Thus a fabricator need not invest in costly coating equipment until after his production experiments with new products or new manufacturing methods are an assured success. In the "production line" laboratory, chemical coatings are applied to metal surfaces by two methods—automatic sprays and rollers. As shown, the roller coating unit can be removed from the line, making the laboratory machine highly flexible and thus adaptable to a variety of metal surface treatments.

HOLDING company keyed to meet increased printing needs in the fields of factory instrumentation and office automation has been formed by five specialty printing firms and a national sales organization. President of the new com-

another automated device from Feedall

NEW AUTOMATIC

Feedall

Combines barrel-dump self-loader and variable-speed elevating feeder

SPECIFICATIONS

Model 9000 Barrel Dumper

CAPACITY: handles up to 1100 lbs. of material.

CONTROLS: push-button operated, with magnetic brake motor. No air or hydraulic system required.

SPEED: can be cycled to conveyor line, or actuated by feeder cycle.

SIZE: occupies less than 8 square feet.

This versatile unit does a lot of cost-saving — and speeds production too. It combines two standard Feedall machines into a single parts-feeding unit, eliminates costly hand-feed, adds steady production flow, and cuts handling time.

Outstanding feature is the new push-button controlled Barrel Dumper, Feedall Model 9000. It handles up to 1100 lbs. of material, loads the Feedall 2500 Elevating Conveyor, and speeds both parts handling and conveyor operation. Designed for heavy-duty service, the Barrel Dumper has welded-steel plate construction and simple operating controls. The complete unit occupies less than 8 sq. ft. of floor space.

Both Feedall machines are available separately. There's extra economy, too, in the flexible designs which can be readily adapted to special needs.

Details can be obtained in the latest Feedall catalog, complete with estimate data sheet. Write for your copy . . . or send us sample parts and include brief facts. Our engineers will do the rest, promptly.

Feedall

Producers of automatic feeding devices
FEEDALL, INC., WILLOUGHBY, OHIO

ELEVATING, BLADE, TUMBLE, VIBRATORY FEEDERS • TRANSFER AND ELEVATING CONVEYORS • SPECIAL SELECTOR DEVICES

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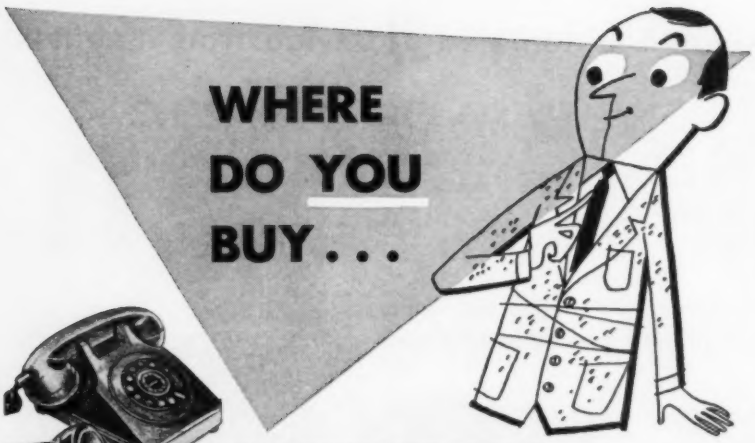


TELEPHONE INSTRUMENTS — Desk phones, in black and 7 color-tones. Wall phones. Units engineered to specifications.

TELEPHONE HANDSETS — Standard and "Push-to-talk" sets. Receiver and transmitter units. Cords, straight and coiled.

DIALS — Standard 10-impulse dial with spring combinations to fit most requirements.

RELAYS AND SWITCHES—Standard and miniature telephone type relays, Reed Armature relays and Matrix switches, Hermetically sealed shock and vibration resistant miniature and sub-miniature relays, Rotary and Crossbar switches, Mountings and frames for single and multiple configurations.

PLUS a wide range of: Keys, Terminal blocks, Lamp strips, Multi-terminal plugs and jacks, Coils, and allied components.

North is a manufacturer and prime supplier of these and many other communication components for original equipment manufacturers. All North equipment is backed by over 75 years' experience in the communications and electronics fields.

FOR A RELIABLE SOURCE OF SUPPLY YOU CAN DEPEND ON NORTH

INDUSTRIAL DIVISION

NORTH ELECTRIC COMPANY

729 SOUTH MARKET STREET • GALION, OHIO

Available in Canada through Ericsson Telephone Sales of Canada, Ltd., Montreal 8, P. Q.

pany, Graphic Controls Corp., is **M. B. E. Clarkson,** vice-president of Technical Charts Inc. The subsidiary companies of Graphic Controls Corp. specifically in the instrumentation recording field, are Staebler & Baker Inc., Staebler & Baker Ltd., Technical Sales Corp., Clarkson Press Inc. and Amherst Printing Co. Inc. Each subsidiary company will continue to operate as an autonomous concern, with the holding company co-ordinating over-all policies.

PROCESS VAPOR fractometer, a Perkin-Elmer model with analyzer in explosion-proof housing. Recorder and programer units are also shown. This instrument extends the laboratory gas chromatography technique to continuous process stream analysis. The instrument has been field tested on such typical applications as the analysis of butadiene product and raw material, alkylation feeds, ethylene, chlorinated hydrocarbons and general refinery streams containing both olefins and paraffins from methane through pentanes. Other promising applications include analysis of synthesis gases used in the manufacture of ammonia, acetylene, methanol and ethylene oxide.

Transistor Home-Study Course

DESIGNED for electronic service technicians, a transistor home-study course is offered by the CBS Tube Division. The course includes ten lessons and covers not only simplified basic theory on how transistors work, but also provides for many practical experiments and servicing techniques for a variety of transistor amplifiers, oscillators and rectifiers. Free correction and consulting service is provided as part of the course.

ERIEZ MAGNA-RAIL UNITS SPEED UP CONVEYOR LINES, CONSERVE VALUABLE FLOOR SPACE!

Small, lifetime-powered magnetic automation elements fastened under conveyor belts provide safe, positive hold for ferrous parts; swiftly convey, control and elevate up inclines as steep as 80°; increase safety conditions and reduce damaged parts.

Speed up production and reduce operating costs with Eriez Magna-Rail! These units, fastened under existing lines or incorporated into new ones, turn ordinary belt conveyors into **magnetic** conveyor-elevators that are able to move ferrous materials and parts at greatly increased speeds.

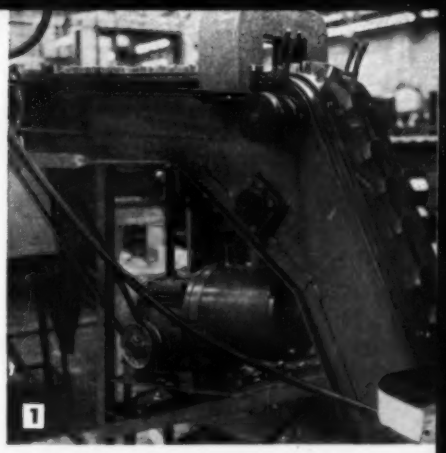
Powerful magnetic action of Magna-Rails holds items such as nails, caps, cans, stampings, scrap, finished parts, etc. at fast speeds even up (or down) inclines as steep as 80°. Convey on both top and bottom sides of your lines . . . automatically turn conveyed parts over . . . change direction of flow, etc. Use of steeply inclined conveyor lines shortens belt lines, permits machines to be more closely grouped together. Positive hold prevents items from slipping off the line; improves safety conditions, reduces damaged parts.

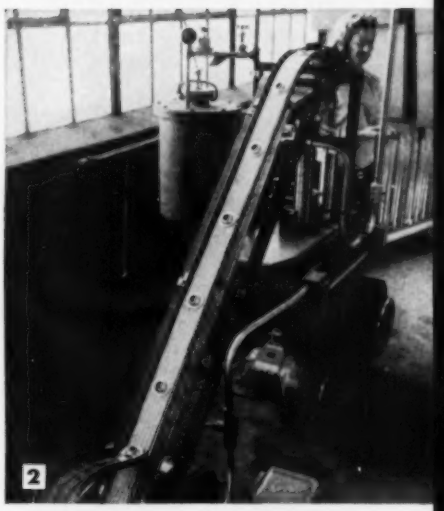
Magna-Rail is a 4" wide assembly, standard lengths from 3' to 6', containing a series of Alnico V non-electric magnets. The unit is available in straight or curved sections for direction change of a conveyor line. Magna-Rail will **automatically** convey, control or elevate material from one machine (or operation) to another, with automatic discharge where required. When used with other Eriez HI-POWR magnetic equipment, these units offer unlimited automation advantages.

Lightweight and simple in design, Magna-Rails are easily incorporated into present conveyor lines. No outside power is needed, and maintenance is nil. Magnetic strength is guaranteed indefinitely.

• • • • • • • •

Eriez does not design, build or sell material-handling systems, *but we serve people who do* in areas where magnetic equipment should be incorporated. We willingly share the design-and field-application know-how gained through helping others move materials faster, more economically, more efficiently and more accurately by utilizing the inherent advantages of magnetism. Specifically, we produce standard lines of magnetic equipment and, in addition, design and build special components to *magnetically* convey, transfer, control, elevate, re-position, hold or re-orient basic ferrous material or finished parts. As our engineers work very closely with both system manufacturer and ultimate user, the most efficient installation is the end result.





ERIEZ MAGNA-RAIL UNITS PROVIDE THESE IMPORTANT AUTOMATION ADVANTAGES:

• Magnetic strength is guaranteed indefinitely; first cost is the only cost • Completely non-electric; no wires or attachments • Easily incorporated into new or existing equipment • Virtually no maintenance; magnets are trouble-free • Compact size: 4" wide, $1\frac{15}{16}$" high. Standard sizes are 3, 4, 5, 6 ft. (special sizes made to order) • Safe, positive hold • Permits faster conveyor speeds in less space • Lightweight; simple design • Eliminates manual handling, reduces damaged parts • Conveys up inclines as steep as 80° • Many magnetic strengths

Produced under Patent 2, 551,947.

***BIG, NEW BULLETIN** on magnets for automation.*

For your free copy, write:

ERIEZ Manufacturing Company
119W Magnet Drive, Erie, Pa.

ERIEZ HI-POWR MAGNETS FOR AUTOMATION

PIONEERS AND WORLD'S LARGEST PRODUCERS OF PERMANENT NON-ELECTRIC MAGNETIC EQUIPMENT AND NEW HI-VI ELECTRO PERMANENT MAGNETIC VIBRATORY EQUIPMENT

MAGNA-RAIL SOLVED THESE CONVEYING PROBLEMS:

1. **Cleveland Graphite Bronze Division, Clevite Corp.** Problem: to secure bushings and bearings to a conveyor belt without marring their close tolerances and mirror finish by sudden belt stops or inclines. Solution: MAGNA-RAIL
2. **Sherwin Williams Company.** Problem: to convey paint can tops more quickly without having them slide off the line and to discharge them automatically at the rate of about 100 per minute. Solution: MAGNA-RAIL
3. **R. T. French Company.** Problem: to elevate caps for mustard jars up a steep incline, over a conveyor line, and automatically release them into the hopper of a capping machine. Solution: MAGNA-RAIL
4. **National Can Company.** Problem: to convey can ends at the rate of 200 per minute from a press to a coater, without danger of the ends sliding off the line at this rate of feed. Solution: MAGNA-RAIL

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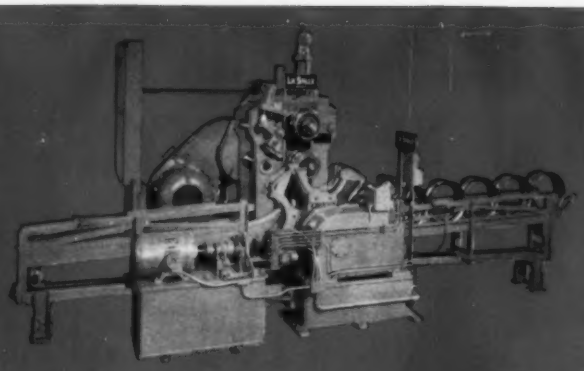
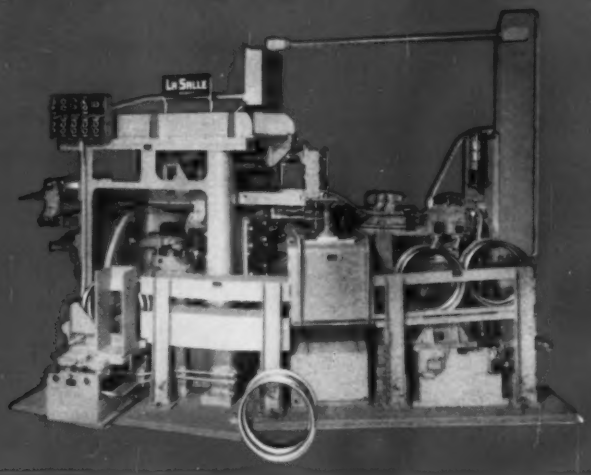
La Salle

Wheel Rim-amatic

new wheel rim automation line





Engineered to give you machine tool precision, High Speed production and complete automation

3 Interlocked Forming Machines

It's a series of three forming machines, with automatic load and unload mechanisms, electrically interlocked to form a continuous line. It's designed and built for the volume production of precision formed wheel rims.

Self-Contained

The Self-contained units are completely wired, with many built-in features, and are ready for immediate use. You merely connect the power lines, once the machine has been set in position—and it operates automatically.

LaSalle Shuttle Transfer

An automatic (LaSalle) shuttle transfer mechanism moves the wheel rims to the load position on the final sizing press, from a vertical plane in the third forming machine, to a horizontal plane in the final sizing press.

Automatic Features

The wheel rims progress through this new precision machine—through the 3 interlocked forming units—as a continuous automatic operation. EVERY OPERATION IS COMPLETELY AUTOMATIC! Here's a simplified version of what takes place along the way in this new "LaSalle Wheel Rim-amatic"—after proper channelling; proper cycling; proper indexing; and, precision forming, the finished wheel rims are fed from the final sizing press—automatically.

Production Plus

This new LaSalle wheel rim automation line, already in operation in a manufacturing division, of one of the Big 3, where precision and high production is a must, has proven to be a real production asset.

Requests for information honored promptly.

La Salle tool, inc.

ENGINEERING & BUILDING SPECIAL MACHINERY

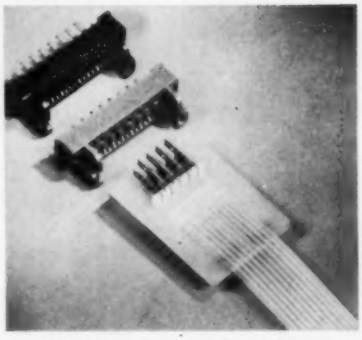
3840 EAST OUTER DRIVE • DETROIT 34, MICHIGAN

Multiconductor Cable Introduces Design and Manufacturing Improvements

INTRODUCTION by Tape Cable Corporation, Rochester, N. Y., of a flat, multiconductor, ribbon-like electrical cable, known as Tape Cable has added latitude to the field of electrical design. The cable is a ribbon-like, flexible film in which are imbedded flat copper conductors 0.0015-inch thick. The conductors are parallel and are surrounded by transparent polyester insulation. This results in a cable having minimum cross sectional area, minimum inter-conductor capacitance, high tear strength, high flex life, and high resistance to chemical attack.

Conductors in standard Tape Cable have 0.100 inch center-to-center spacing in accordance with the recommended RETMA grid pattern for printed wiring. Nine standard sizes have been established, having 9, 14, 17, 21, 27, 30, 36, 40 or 50 conductors.

The most striking electrical characteristic of Tape Cable is its low interconductor capacitance. Since it is less than 5 mmfd per foot between conductors, Tape Cable is ideal for high frequency applications. Grounding alternate conductors will reduce the interconductor capacitance to under 1 mmfd per foot in free air. Because of the large heat dissipating characteristics of flat conductors, each conductor in Tape Cable has a conservative rating in free air of one ampere. This is adequate for most signal circuit requirements. It is interesting to note that a conservative rating of 300 volts is achieved with a maximum cable thickness of only 0.011 inch.



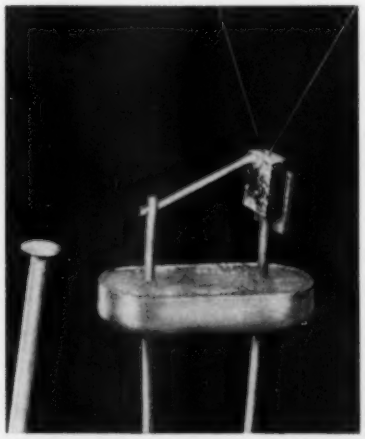
FLAT CABLE shown with circuit connector. Cable is supplied in reels and allows simplified usage with printed circuits due to the coplanar configuration of both the ribbon cable and printed circuits. Saving of 85 per cent in copper over conventional cable having round conductors of the same current handling capacity makes the ribbon cable especially desirable where weight and space are critical.

Tape Cable allows a number of conductors to be treated as a single wire. This reduces the assembly and maintenance costs of multiconductor installations. For example, all or any number of the conductors in a single cable may be stripped rapidly and easily in one operation by a pair of opposing high speed glass fiber wheels. The stripped conductors of each cable may be handled as a unit and two or more cable ends brought together, dip-soldered and insulated with tape to form a splice. Harnesses can be made by expanding this technique. Since Tape Cable is available in rolls of lengths up to 1000 feet, it is ready to use in a wide variety of designs, and is not limited to any specific lengths. Material may be rapidly cut to length, either with scissors or an automatic tape dispenser.

Paperwork Importance Cited

BENEFITS of increasing mechanization may be lost or seriously impaired unless integrated paperwork programs are adopted by industry, according to **R. A. Shiff**, president of Naremco Services Inc. He says, "The advantages of having a highly automated plant are offset when production specifications and schedules for delivery are buried in a welter of forms. Management needs more precise data with less paperwork if it wants to improve its control over production, keep its customers happy and maintain its competitive position."

Speaking before an American Management Association meeting in Chicago, Shiff urged plant managers to re-evaluate their paperwork procedures, "If management is to get a firmer grip on control of production, one hand must know what the other is doing."



EXPERIMENTAL assembly of the spacistor, Raytheon's new contribution to the electronics field, shown alongside an ordinary pin. Still in the research stage, the device combines many of the best properties of vacuum tube and transistor. It is expected to amplify up to 10,000 megacycles or as much as 50 times higher than transistors. Also, because spacistors can be made from materials unsuited for transistors, they are expected to operate at temperatures up to 500C or more than double that of today's germanium or silicon transistor temperature limits.

Beta Source and Detector Used In Liquid Level Switch

RADIOACTIVE material is used in the sensing element of a liquid level switch that has been placed on the market by the Aeronautical Div. of Robertshaw-Fulton Controls Co. The unit is primarily designed to meet the needs of the airframe industry for a fuel level control device that will perform reliably and accurately under extremes of temperature, vibration and shock.

The liquid level switch consists of a pencil-size sensing probe—containing a hermetically sealed beta source and a beta detector—which is mounted inside the fuel container. The beta source and detector are separated by a small cavity into which liquid may flow. When no liquid is present, radioactive particles pass from the beta source to the detector tube, but when liquid enters the cavity, it absorbs the particles and thus re-

Actual photograph of control center bus structure being tested under bolted fault conditions with test oscilligrams superimposed.

New Westinghouse Control Center

Tested at 25,000 amperes with no injury to bus

At the Westinghouse high power laboratory, control center safety features are tested under maximum fault conditions to prove dependability of new design

Safety Features incorporated into the design of the New Westinghouse Control Center fully protect both personnel and equipment. Extensive tests in the Westinghouse High Power Laboratory, including maximum fault conditions, conclusively prove these features make the Westinghouse unit industry's safest control center.

With complete interchangeability between 9⅓ and 14 inch modular units, simplified installation, and increased safety, Westinghouse Control Centers make possible the most compact, economical centralized control system.

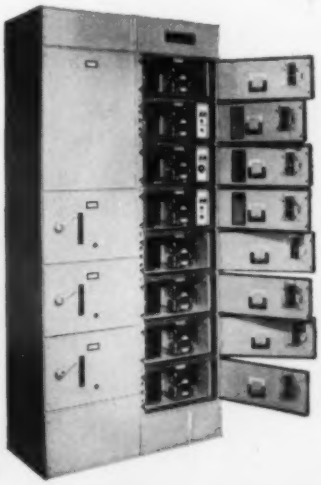
For complete information on the Westinghouse Control Center, call your Westinghouse sales engineer, or write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa. J-22060

YOU CAN BE SURE...IF IT'S

Westinghouse

DOOR HANDLE SHOWS BREAKER POSITION with no guesswork. Breaker must always be in "off" position before door can be opened, eliminating any chance of personnel touching a "live" unit.

GUIDE RAILS PROVIDE FOOLPROOF ALIGNMENT of stabs. No need to juggle unit into position, no chance of shorting bus with unit. Guide rails support unit and insure positive alignment of stabs.



ROLLED DOOR EDGES WITH NEOPRENE GASKETING provides protection for components against dust, moisture, fire or contaminants. The complete control center is safer . . . less subject to atmospheric damage.

Circle 667 on Inquiry Card

duces the radiation level at the detector. The variation in radiation is converted to an electrical signal which is amplified by a transistorized circuit to actuate a relay. The relay is used to switch on warning lamps, valves or servomotors according to some prearranged system.

MEETINGS AND EVENTS

Sept. 9-13—

Instrument Society of America. Twelfth Annual Instrument-Automation Conference and Exhibit to be held Cleveland Auditorium, Cleveland. Additional information may be obtained from H. S. Kindler, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 17-18—

Radio - Electronics - Television Manufacturers Association. Symposium on Numerical Control Systems for Machine Tools to be held Ambassador Hotel, Los Angeles. Additional information may be obtained from RETMA, Room 650, 11 W. 42nd St., New York 36, N. Y.

Sept. 23-25—

American Society of Mechanical Engineers. Fall meeting to be held Statler Hotel, Hartford, Conn. Additional information may be obtained from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 24-26—

Sixth Annual Industrial Electronics Symposium. Co-sponsored by IRE and AIEE, to be held Morrison Hotel, Chicago. Additional information may be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Oct. 7-9—

Second Conference on Manufacturing Automation. Co-sponsored by Purdue University and AUTOMATION Magazine, to be held Purdue University, West Lafayette, Ind. For information contact the Editor, AUTOMATION, Penton Bldg., Cleveland 13, O.

Oct. 7-9—

National Electronics Conference. Co-sponsored by Illinois Institute of Technology, AIEE, IRE, and Northwestern and Illinois universities. To be held Hotel Sherman, Chicago. Additional information may be obtained from Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 14-15—

Fourth Conference on Mechanisms to be held at Purdue University, West Lafayette, Ind. Sponsors are the Purdue School of Mechanical Engineering and *Machine Design*. Additional information can be obtained from the Editor, *Machine Design*, Penton Bldg., Cleveland 13, O.

Oct. 16-18—

Computers in Control. Conference sponsored by Feedback Control Systems Committee of AIEE; Professional Group on Automatic Control of IRE; and Instrument and Regulator Department of ASME to be held Chalfonte-Haddon Hall, Atlantic City. Additional information may be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Oct. 17-18—

National Conference on Industrial Hydraulics. Sponsored by Armour Research Foundation of Illinois Institute of Technology. To be held Hotel Sherman, Chicago. Additional information may be obtained from Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 24-25—

Computer Applications Symposium. Sponsored by Armour Research Foundation of Illinois Institute of Technology. To be held Hotel Sherman, Chicago. Additional information may be obtained from Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

"I realize you have a B.S. and M.A.—but can you work on 110 volts a month?"

Oct. 28-31—

Trade Fair of the Atomic Industry. To be held at New York Coliseum concurrently with meetings of Atomic Industrial Forum and American Nuclear Society. Additional information may be obtained from Atomic Industrial Forum, 3 E. 54th St., New York 22, N. Y. or John Burt, J. M. Mathes, Inc., 260 Madison Ave., New York 16, N. Y.

Nov. 2-10—

International Congress and Exhibition of Measuring Instrumentation and Automation. Sponsored by trade associations in the fields of measuring, telemetering and control instruments for electrical and processing quantities as well as analytical equipment for production control and research. To be held at Dusseldorf, Germany. Further information may be obtained from Nordwestdeutsche. Ausstellungs - Gesellschaft m.b.h. (NOWEA), Dusseldorf, Germany.

Nov. 4-8 —

American Society for Metals. World Metallurgical Congress and National Metal Congress and Exposition to be held at International Amphitheatre, Chicago. Further information is available from American Society for Metals, 7301 Euclid Ave., Cleveland 4, O.

Nov. 4-8—

Institute on Electronics in Management. Program on Current Developments in Automatic Data Processing Systems to be held at Downtown Center of the American University in Washington, D. C. Additional information may be obtained from the American University 1901 F St. N.W., Washington 6, D. C.

Nov. 4-6—

American Institute of Electrical Engineers. Machine Tool Conference to be held at Hotel Schroeder, Milwaukee, Wis. Additional information is available from E. F. Mekelburg, Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.

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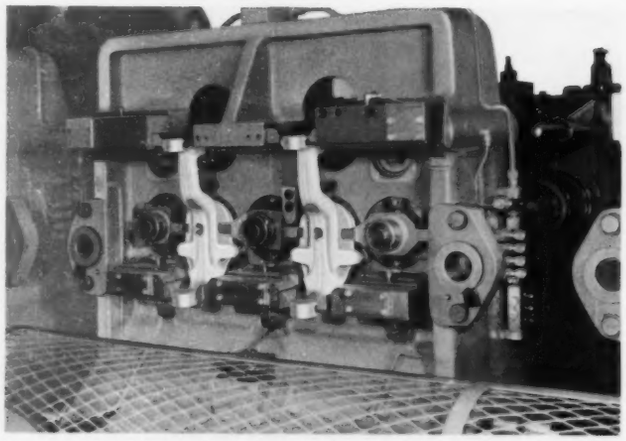
automotive steering knuckle
(TWO VIEWS, SAME PART)

with fixtures like this...



built to hold the parts rigidly without distortion

BUHR ECONOMATIC

setting the pace in the performance of complex operations in modern

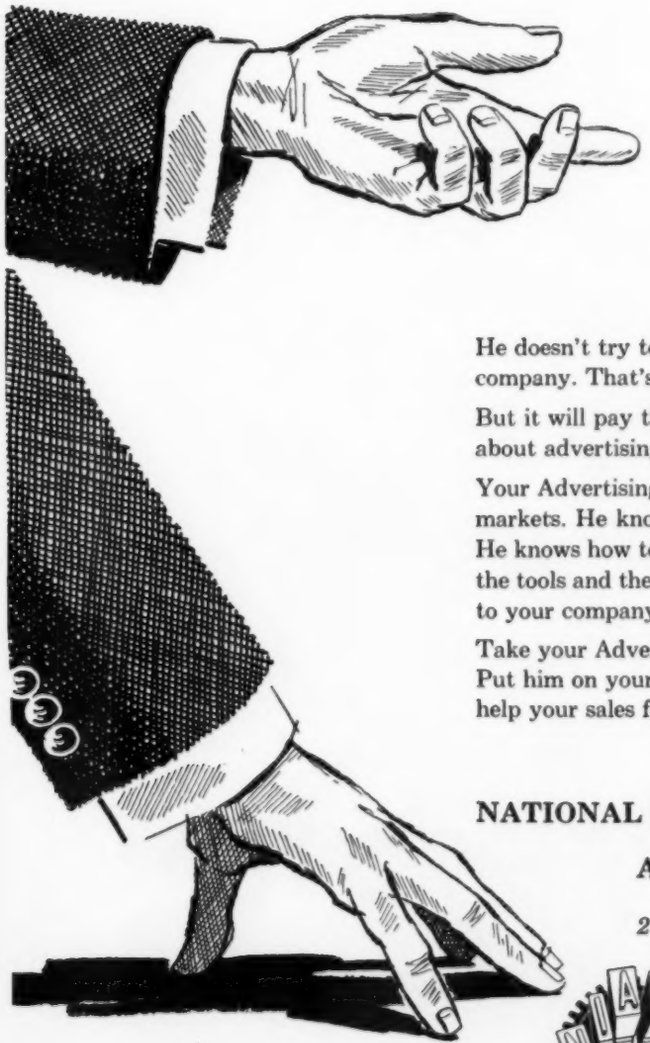
ECONOMATION

"ECONOmical auto**MATION"**

BUH ECONO

sets precedent with the be to process difficult pa like this...

Does your Board of Directors listen to this man?



He doesn't try to tell your Directors how to run the company. That's their job, and he respects it.

But it will pay them to listen to him when he talks about advertising for your company. That's his job!

Your Advertising Manager is a man who knows markets. He knows the science of "mechanized selling." He knows how to help turn sales goals into sales. He has the tools and the know-how to make major contributions to your company's progress and profit.

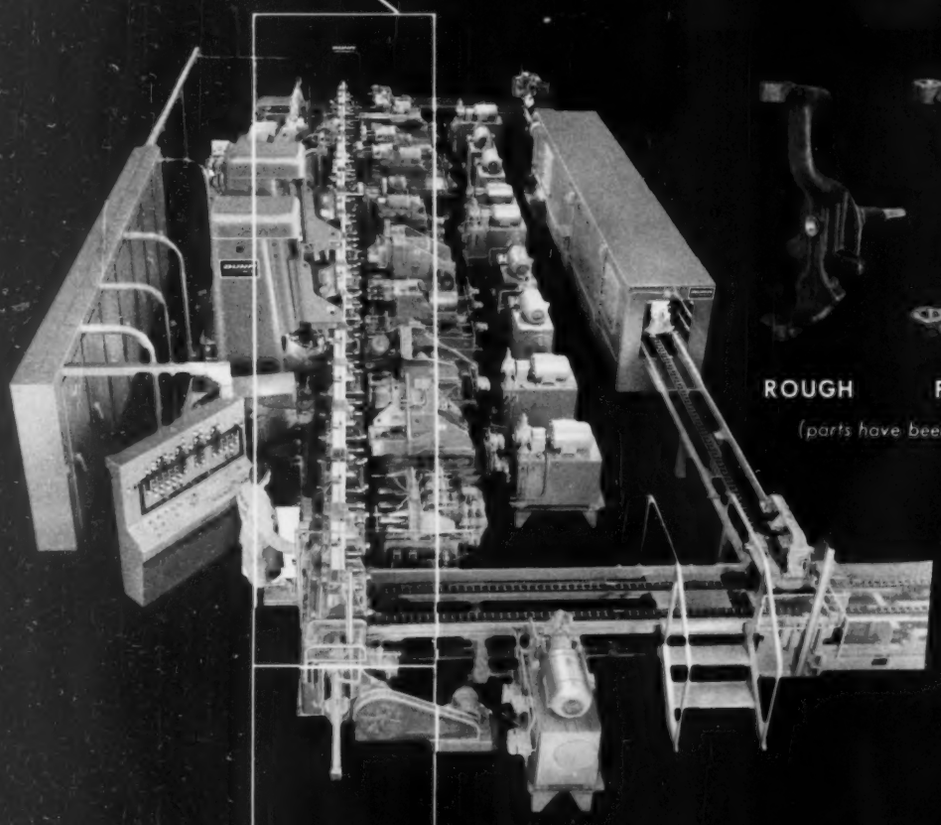
Take your Advertising Manager into your confidence. Put him on your first team. Let him manage. He can help your sales force sell more economically.

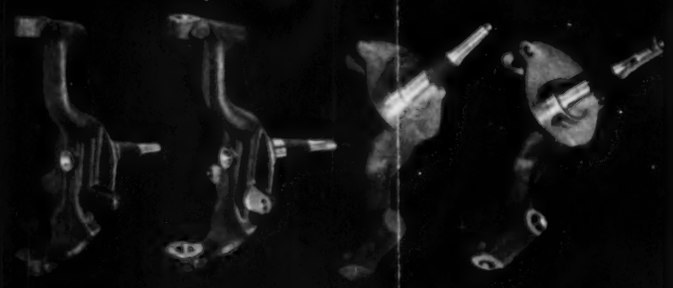
NATIONAL INDUSTRIAL ADVERTISERS ASSOCIATION, INC.

271 Madison Avenue, New York 16, N. Y.

An organization of over 4000 members engaged in the advertising and marketing of industrial products, with local chapters in ALBANY, BALTIMORE, BOSTON, BUFFALO, CHICAGO, CLEVELAND, COLUMBUS, DALLAS-FORT WORTH, DENVER, DETROIT, HAMILTON, ONT., HARTFORD, HOUSTON, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, MINNEAPOLIS-ST. PAUL, MONTREAL, QUE., NEWARK, NEW YORK, PHILADELPHIA, PITTSBURGH, PORTLAND, ROCHESTER, ROCKFORD, ST. LOUIS, SAN FRANCISCO, TORONTO, ONT., YOUNGSTOWN.

BUHR ECONOMATIC sets prec



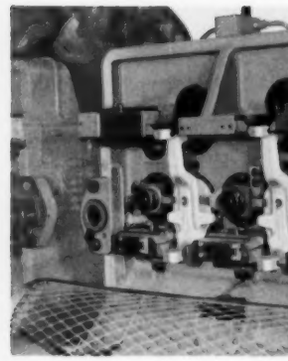


ROUGH FINISH ROUGH FINISH

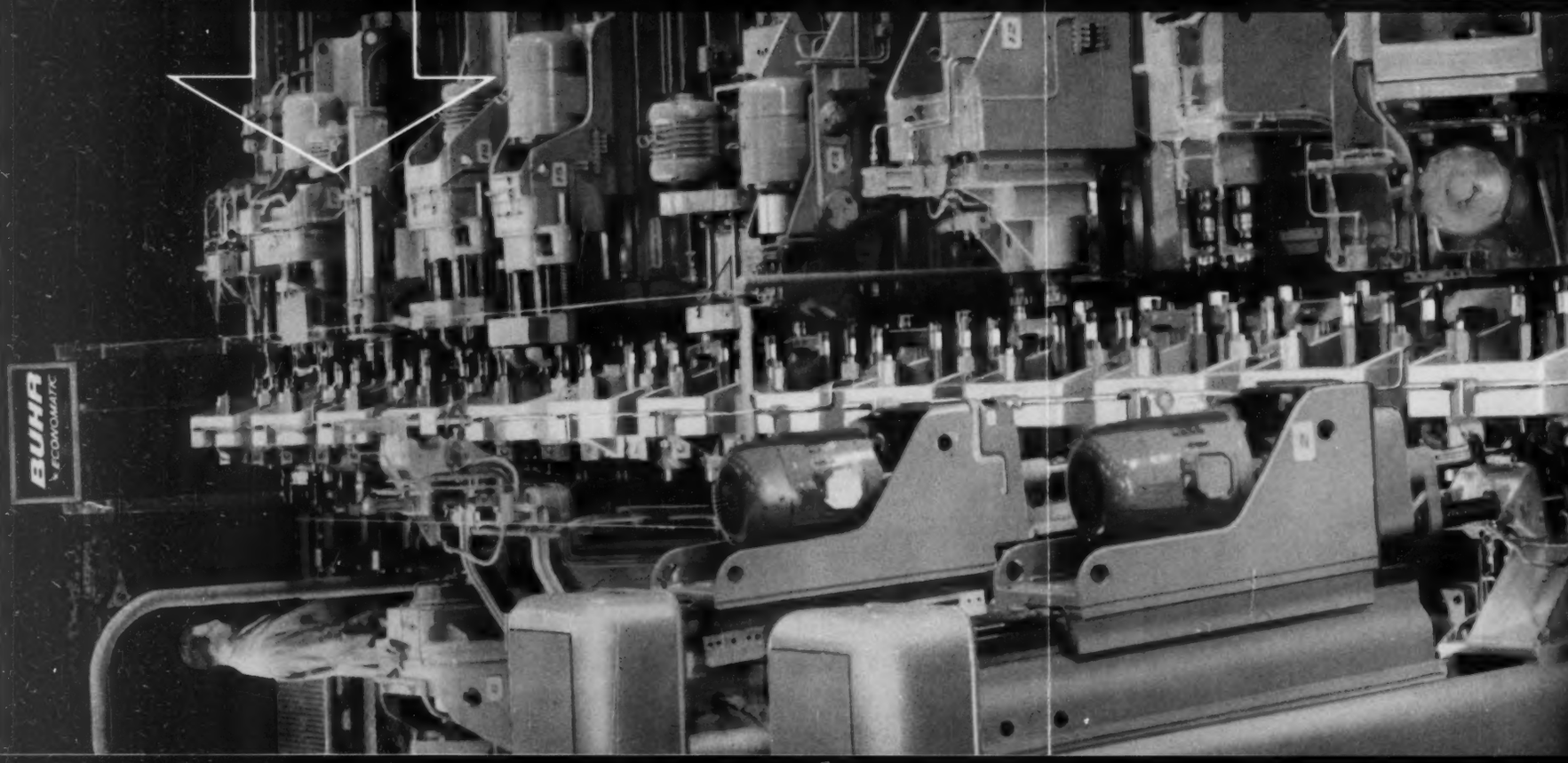
(parts have been ground and qualifying pads broached)

operations

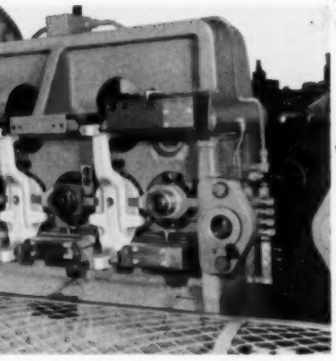
(4) milling, (8) drilling,
(2) rough taper-reaming,
(2) finish taper-reaming,
(2) spot facing, (5) chamfering,
(1) tapping, (1) threading,
(1) steel-brushing and (3) probing



- automatic probe a
- special Buhr sectio
- standard and spec
- spindles arranged
- hardened and grou
- central-mist lubric
- individual push-bu

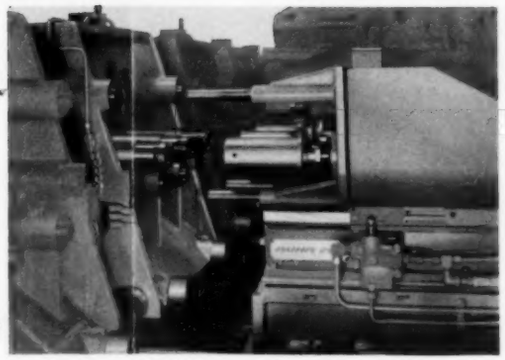


precedent by performing 29 operations on two steering knuckles every 32½ seconds!

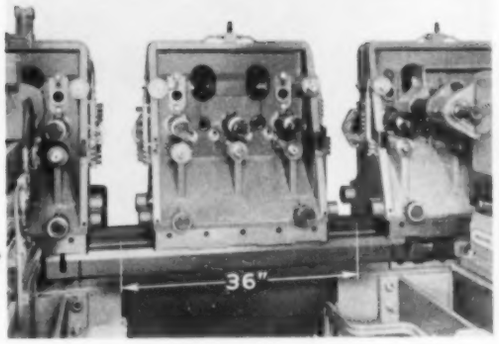


PARTS IN CLAMPED POSITION

INDIVIDUALLY-CONTROLLED TORQUE WRENCHES



ONE OF FOUR IDLE STATIONS



standard features

atic probe and blow-out before tapping
Buhr sectional-base construction to facilitate future part changes
rd and special parts interchangeable for ease of maintenance
es arranged for pre-setting of cutting tools
ed and ground steel ways
-mist lubrication on spindle heads
ual push-button stations on feed-units

- J.I.C. Standards throughout
- automatic lubrication of all moving parts
- lube-fault alarm system
- positive pallet-clamping

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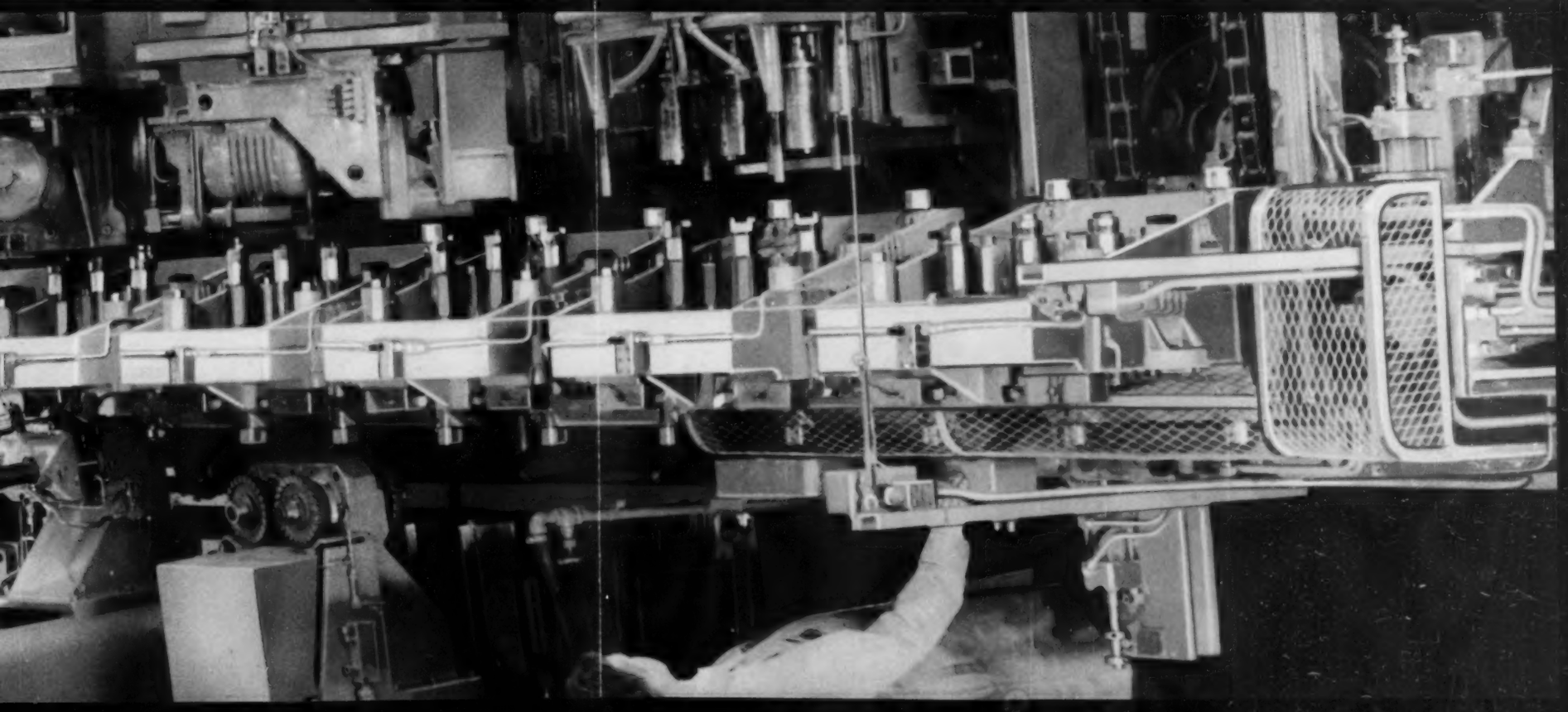

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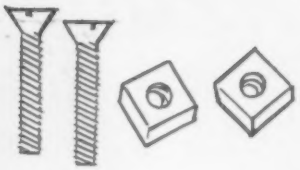
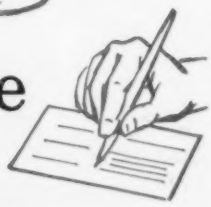
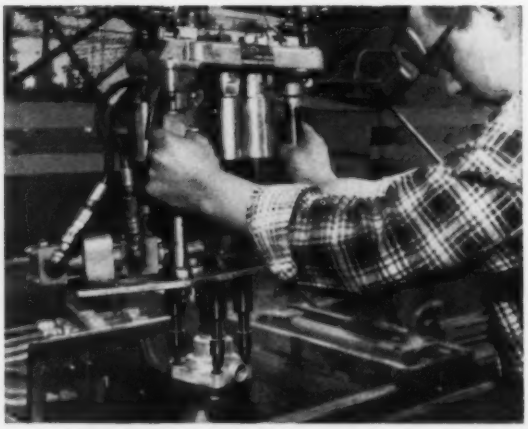
If you assemble products with 2 or 20 fasteners  Thor Multiple nut setters and screwdrivers can save you money and give you better quality. Write  today for Thor's Multiple story—it's



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By JAMES C. KEEBLER
Managing Editor

Three machine setup of Roto-Flo spline rolling machines cold works involute splines onto rear axle shafts for all five lines of Chrysler Corp. cars. Parts are hand-loaded to belt conveyor at previous operation and proceed automatically through splining operation.

Working Metal

METALWORKING is a phase of industrial production that is of prime concern to the automakers. *Steel* magazine concerns itself exclusively with metalworking activity and in assessing present developments has seen fit to look at the days ahead as "Metalworking's Fabulous Future."

Though AUTOMATION and automaters concern themselves with automatic operations of all types whether they work metal or not, the fact that metalworking is such a large part of automaking keeps us looking at what's cooking with these workers of metal, because we've a big stake in that *fabulous future.*

Used Material

Aside from the chemical and physical properties that make this stuff called *metal* so useful in functions of modern products, another claim to fame is the fabulous number of different ways it can be worked. You can cast it, roll it, bend it, cut it, weld it and even "disintegrate" it to produce the configurations of your heart's desire. To do this it's heated, squeezed, bumped, struck, restruck, sheared, shaved and often processed into a pile of chips.

Automakers have even been accused of preferring metal to other materials because they get it back again. When a succession of customers gets done driving the old jalopy that is no longer resaleable as "transportation," a junk dealer takes title to the once gleaming motor car and soon it's remelted into the makings of another.

Though the staff R&D groups may plead the fifth amendment when it comes to questions of ulterior economic motives, the planners of automated processes will readily admit that they're conniving to work this metal into the shape and unexcelled performance of a 1958 model by the least costly techniques they can perfect.

The author of this ball of yarn has noted in certain past exposures to this readership that one trend in metalworking today is away from strict concern with the making of chips. Some claim that if you can make metal parts of the shape you want without also making piles of chips you can probably save a few bucks in the end, even though you lose the revenue from the sale of scrap. (It has been observed that although chips are not particularly difficult to make, their high cost is credited to the lengthy machining times required before you get enough of them to sell.)

Pointed Case

A case that illustrates the point is the rolling of splines on rear axle shafts at Chrysler's Lynch Road Plant. Those process men who cut their eye teeth on spline teeth prior to the turn of the decade learned that the classic methods of producing involute splines included the generating techniques of hobbing, gear shaping, full-forming by broaching, or the more laborious work of form milling and indexing until the job was done.

Surely each of the classics still has its place (it's hard to imagine rolled internal splines) but this rolling method looks like it will put the squeeze on more than axles. Generating involute profiles with cutting tools involves producing a succession of fine chips which leave a surface of the desired contour. The more accuracy required on the profile, the finer the chips must be. The finer the chips, the longer it takes to cut the teeth. In cases of high accuracy requirements the answer was to

shave, lap or grind on a secondary operation. Added operations don't usually reduce manufacturing costs.

One man operating three or four machines or work stations has been the rule for hobbers and shapers for years. This condition did not result from the use of automated handling devices that load and unload the automatic cycling machines, but rather from the fact that it takes so long to cut the teeth that the operator can do much other useful work between the time he loads the part and the time it is ready to unload.

Formed Cold

Small wonder the Roto-Flo process developed by Michigan Tool Co. has an appeal to the automakers. The idea exploited here is to cold work the metal into the shape required without chewing out chips. This is similar to rolling threads instead of chasing them, except the helix angle in question is 90 degrees and the tool takes the shape of a rack instead of being circular. Blank parts are plain rounds. Material displaced from between the pitch diameter and root diameter is forced into the flanks of the teeth and the finished outside diameter is larger than that of the blank.

Basic machine has rack-type forming tools mounted on two slides in a *C* shaped machine frame. Slides are mounted one above the other and geared together with master racks (not the tool racks) and a connecting gear. Lower rack is the prime mover and gains its power from hydraulic cylinders.

Workpieces are fixtured so they are free to rotate as the tool racks move. Racks are designed to press into the part until full depth is reached, then a few additional turns are made at full depth.

Chrysler's requirements at Lynch Road are for 12,000 rear axle shafts per day. For splining the end of these shafts, made in three different body sizes, the plant formerly used six multi-spindle hobbers. Now only three Roto-Flo cold-forming machines do the job—and produce a better product. These machines extend the cold-forming process to accurate machined parts with a number of manufacturing advantages. Product quality is improved, both from the standpoint of structural strength and surface finish. Tool costs per piece are slashed. Other cost advantages include smaller floor space requirements and lower capital investments in machinery and chip-removal facilities.

Spline production in this setup involves forming 30 teeth, 1.620 inches in length. Diametral pitch of the spline is 24/48, pressure angle is 30 degrees. Outside diameter is 1.290 inches. Root diameter is 1.185 inches.

Chrysler uses three spline rollers in an automated installation interconnected by belt conveyors. Average production rate is 360 splined shafts per hour from each machine. The splines are produced with a 5 microinch surface finish, considerably better than teeth formed by other processes.

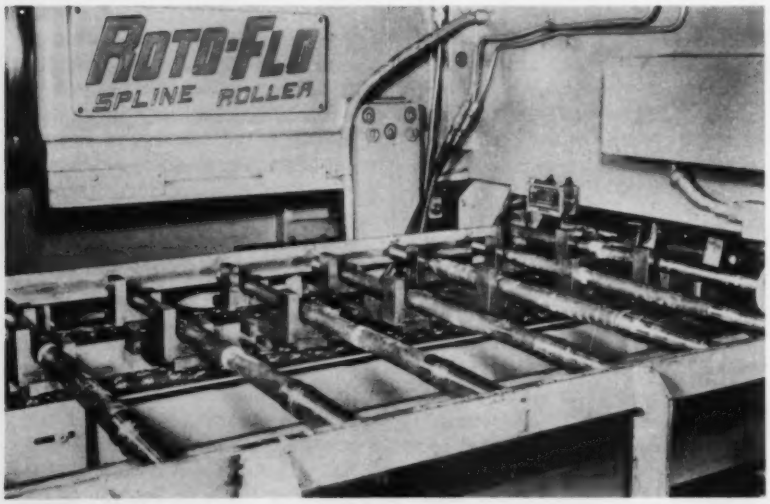
The operator on the prior operation places the parts on a belt conveyor that automatically loads them into V-shaped slots on the individual machine-loading conveyors. Once loaded, further operator attention is not required through the work cycle. Parts are returned by the machine conveyors to another belt conveyor for transfer to the heat treating operation that follows. The change to cold-formed splines has not affected the heat treating operation in any way.

Chrysler Corp. and Michigan Tool engineers working together selected M-2 (a highly compression-resistant molybdenum HSS) for the forming rack material. Rack life has been increased to a minimum of 100,000 parts per grind for these 30 degree pressure-angle splines. In some cases, Chrysler has gotten as many as 200,000 parts from one rack grinding.

Formerly the hobbed splines on these axle shafts were straight sided. Minor diameter is not greatly increased with these fine-pitch rolled involute splines. It adds up to 30 per cent more strength with no increase in size. Tests indicate there's no problem with failure because of spline weakness.

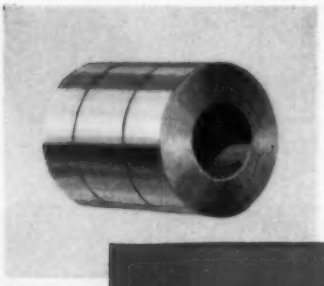
This manufacturing setup has been engineered by Chrysler to take advantage of Roto-Flo's easy tool change. Chrysler does it in 20 minutes without moving the conveyors.

This metalworking technique is working out, for it works automatically to give cold-worked splines of improved quality at lower cost.



Chain conveyors across front of spline rolling machine position axle shafts to be rolled between forming racks. Machine rate is 360 parts per hour.

FROM COIL..



TO STAMPING..

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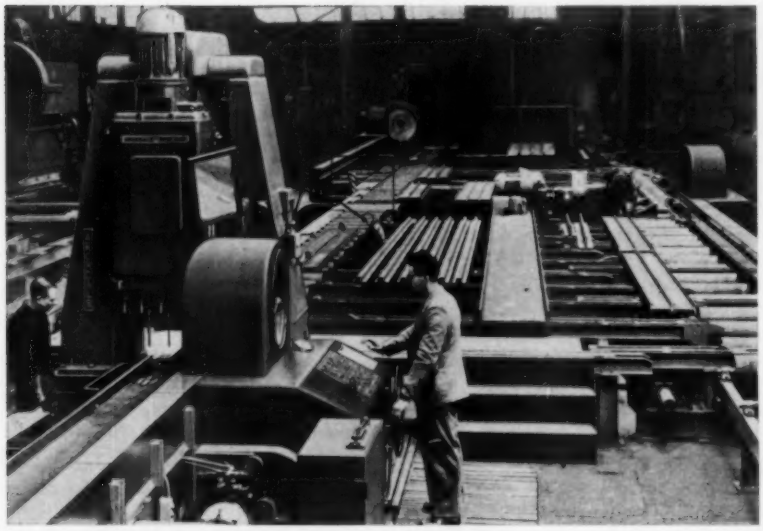
notes from britain

By FRANK G. WOOLLARD
British Correspondent



Stock to be fabricated into structural steelwork moves in a continuous flow pattern from the cold saw in the background to the horizontal and vertical drilling units in the right center and foreground respectively. Measuring means for positioning stock in each machine eliminate template making and marking of notches and holes in various bars.

Change and Control

TWO YEARS AGO the Institution of Production Engineers staged a Conference at Margate, the theme being "The Automatic Factory—What does it mean?" Up till that time the word "automation" was scarcely known in Britain outside engineering circles. After then, owing partly to the conference and partly to the publicity given by the press to Walter Reuther's demand for the Guaranteed Annual Wage, automation became a burning topic. Every species that can hold a pen or give an interview has been writing or giving tongue to the subject whether they know or whether they only surmise. Sir Leonard Lord, Chairman of Austin Motor Co., told the Institution, whose President he then was, that he "feared they had over-sold automation."

Last year the Conference was held in conjunction with a Production Exhibition and the Conference theme was "Investing in Success." Automation played a part in the programme but was not the main theme.

This year the Conference was held at Harrogate, an inland spa, and the theme was "Automatic Production—Change and Control." The programme consisted of two plenary sessions, two case study sessions and 18 discussion sessions. This was compressed into two clear days, i.e, the delegates assembled on Sunday evening and left on Wednesday morning, so it was very like a 3-ring circus.

Lord Halsbury who was inducted into the Presidential Chair on the opening of the proceedings, delivered his Presidential Address, commencing with these words: "Our Conference is concerned with change and control, that is to say, the administration of the most modern production. In administration we are always changing something or else, by control, preventing it from changing spontaneously into something we regard as undesirable. Whether we are initiating something or preventing its spontaneous occurrence, we are controlling. And whenever we control something we do so by reason of a change regarded as desirable or undesirable. Change and control are therefore at the heart of administration."

Automation Principles

The first speaker in the discussion groups was Dr. Lillian Gilbreth who delivered an hour's address with scarcely a note. Her subject was "The Effect of Automation on Management Organisational Principles and Practice." Although she did not say it, in so many words, it is obvious that she regards automation as evolutionary and not revolutionary and that the tenets evolved for management principles and practice will hold good in the automation age. The audience showed their agreement.

Messrs. D. Player and W. K. Temple presented a paper entitled "Machine Tools of the Future." The joint authors are both associated with the Newall Engineering Company Ltd., and the paper was devoted to the importance of accuracy and how it is achieved for coordinate positioning, copying and continuous numerical control.

Mr. G. H. Asbridge, a director of Sentinel (Shrewsbury) Ltd., presented a paper of "The Application of Unit Heads and Special Machines as an Aid to Batch Production." The Sentinel Co. operates under licence from the Renault Co.

of France. The development of the unit head from a component of a transfer machine to a specialized single purpose tool is an interesting side issue which has a very considerable future. Mr. Asbridge provided interesting examples with particulars of the economies made possible by using these heads. They provide, as he says, "very effective automatic machines, virtually tailor-made, from 'off the peg units.' "

Efficient Pressing

One of the most interesting papers, "Transfer Pressing," was written by Gordon Sommer and Robert Barlow both of the Clearing Machine Corp. "It is essential," they say, "that a properly oriented approach to efficient stamping production must include several vitally important factors. Not only must a means be provided to produce stampings at a high rate of production with a minimum of manpower, but means must be provided to reduce to an absolute minimum the changeover time from the production of one stamping to another. This changeover must be accomplished in minutes, rather than hours." Thus three concepts (a) automatic transfer and handling of stampings; (b) rapid changeover time; (c) complete flexibility and versatility; have been borne in mind in these new developments.

A very important paper was submitted by John Loxham, managing director of the Sigma Instrument Co. Ltd. It was entitled "The Control of Quality in Automatic Production." It covered a wide range of automatic inspection devices both for simple pieces and for very complex parts like crankshafts on which 56 dimensions are recorded simultaneously. The author has divided his paper to deal with production processes (a) where the drift in size in relation to time is very slow, i.e., where the process can be considered stable from the standpoint of dimensional change and (b) where the drift is rapid and the process must be considered as unstable from that same viewpoint.

The philosophy advocated in this paper is simple: "everything should be done to control the quality of the product at the only place where the quality of the part can be influenced, i.e., during the manufacturing process." If, however, it is found that independent final inspection is desirable this can still be carried out effectively by some other final form of mechanical inspection equipment.

The second case study session consisted of a discussion on the manufacture of bearing tube, the Stanlow Platformer and the Leo Computer. The studies were presented originally at an E.P.A. Conference on Automation (Paris, 8-12 April 1957) and are published by Political & Economic Planning.

The majority of the papers quoted are those which indicate matters which Britain thinks it necessary to explore in order to advance her development in automation.

Here and There

● In a new plant to prepare structural steel for fabrication. Boulton & Paul Ltd. of Norwich have installed equipment for a continuous flow arrangement. The former making of templates and marking of each piece for cutting and drilling has been eliminated. This step has also done away with the stacking of large quantities of cut material, one of the difficulties encountered with the old system, which encouraged this practice so that the platers engaged in marking off should not be idle. In the old days it was quite usual for two to three hundred tons of cut material to be stacked for marking. With the new system, individual bars are fed through the plant on conveyors in the sequence in which they are ordered and cut.

Marking off is eliminated by provision of measuring equipment on each machine. This equipment is used to position each piece in accordance with an order form which accompanies it through the plant. The measuring equipment consists of an endless chain carrying a feeler arm. This feeler is kept in uniform contact with the end of the bar by means which ensure a constant pressure by the bar against the feeler. Means are provided to compensate for chain wear and stretch, and lengths up to 60 feet can be measured with accuracy.

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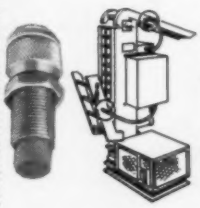
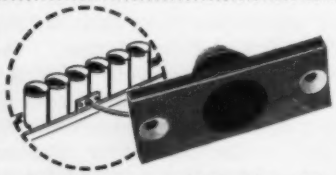
Proximity control unit in JIC enclosure for use with transducers shown. System detects ferrous and non-ferrous metals. For automatic production lines, multiple process machines, parts feeders, conveyors. Maximum rate 600 operations/minute. 4905-RAC $85.



Standard proximity pickup. Detects small metal objects at speeds down to zero. Use for automatic feed, etc. 4910-AN $16.50

Water and oil proof proximity pickup. 4910-WPN $45.00



Extended range proximity pickup with greater sensitivity than 4910-AN. 4915-AN $22.50.
Pancake proximity pickup. Detects large metal masses at greater distances than 4915-AN. 4925-AN $36.50.

Hollow coil proximity pickup. Use for control, batching, switching, automatic operation. Counts small and medium sized parts. I. D. ¼" to 3". 4920-AN $36.50.

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"Your Push-Pulls have eliminated links, radius rods and other lost-motion devices for remote control of hydraulic valves."

Provide ACCURATE Control
"Tru-Lay Push-Pull control cables provide minimum back-lash, even in installations up to 30 feet in length, because the cable is designed to close tolerances with minimum drag and lost motion."

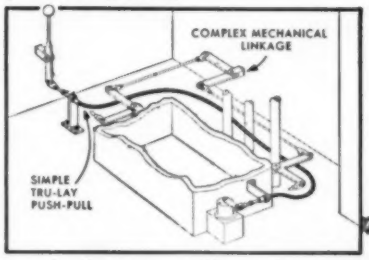
• • •

TRU-LAY PUSH-PULLS are "Solid as a rod but *Flexible* as a wire rope." This flexibility makes it possible to snake around obstructions . . . permits the ideal arrangement of all elements of remote controls.

***Advantages** of Tru-Lay Push-Pull flexibility and simplicity are pictured below—*

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Construction Equipment and **Farm Implements** provide good examples of the wide-spread use of these accurate, simple and dependable Push-Pulls. On Power Shovels, Winches, Graders, Road Oilers, Dump Trucks, Snow Plows, Engine-driven Pumps, Crushers, Tractors, Combines, Corn Pickers, Corn Row Sprayers, Corn Detasslers, Orchard Sprayers, Power-driven Tree Trimmers, Tobacco Picking Machines and others . . .

TRU-LAY PUSH-PULLS are operating unfailingly for the remote control of Hydraulic and Air Valves, Brakes, Clutches, Transmissions, Throttles, Chokes, Governors, Power Take-Offs, Spray Nozzles, Vent Directional Fins and on many other applications.

ACCO *Our DATA FILE will answer all further questions*

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

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There is No Worry about Failures or Maintenance Costs with TRU-LAY Push-Pull Remote Controls

Long Life is a matter of record. We have never heard of a Tru-Lay Flexible Push-Pull Control wearing out in normal service. Failures, that sometimes harass users of more complex controls, are eliminated by the use of these simple, positive-action controls.

Dependable Operation of these controls is a certainty, even under the most adverse conditions . . . HOT as jet engines (note: Tru-Lay Push-Pulls are actually performing on hot jet applications) . . . COLD to 70° F below zero . . . SOAKIN' WET . . . ABRASIVE . . . or just plain TOUGH.

Freedom from Trouble is assured because of such features as . . . full protection of the inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit.

Accuracy is inherent in the basic design of Tru-Lay Push-Pulls. They are precision products, not gadgets.

Capacity ranges from light jobs up to jobs of 1,000 lbs. input. These Push-Pulls will handle jobs 150 feet or more from the control point.

"Solid as a rod, Flexible as a wire rope" aptly describes Tru-Lay Push-Pull Controls. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . it greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Adaptability to all sorts of mechanical situations explains, in large measure, the wide-spread application of Tru-Lay Push-Pulls. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters, and will work with you.

For Further Information—The DATA FILE pictured at the left contains six booklets and bulletins that will answer any further questions you may have about this versatile and dependable tool. It is quite likely that this material will point the way to a simplified solution of your remote control design problems. Write for a copy.

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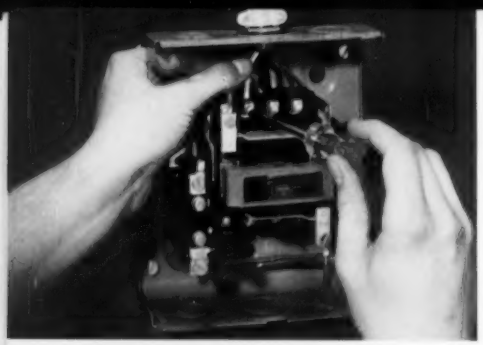
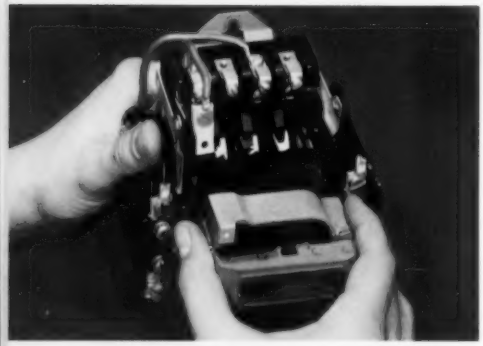
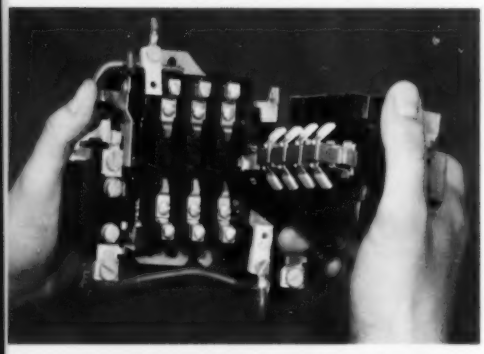
Next Page Circle 675→



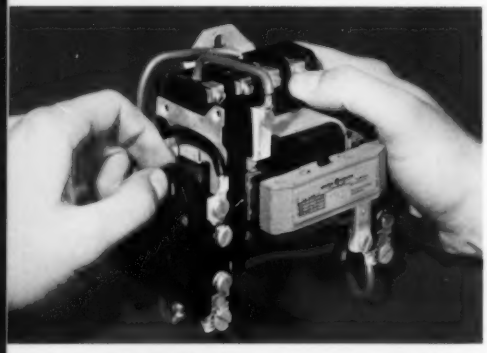
NEW **GREATER WIRING SPACE**
Wrap-around cover—removable enclosure sides make wiring much easier.



NEW **SNAP-SLIDE CONSTRUCTION**
Principal components quickly disassembled for easier inspection and maintenance



NEW **"VERTICAL" CONTACTS**
Continuous dependable operation of new starter—even in dusty atmospheres



NEW **ADJUSTABLE OVERLOADS**
Overload trip setting can be adjusted plus or minus 15% of nominal heater rating.

General Electric announces

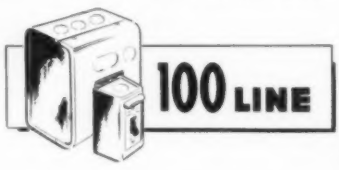
NEW Size 0 and 1 Magnetic Starters—42% Smaller in Size

General Electric now offers a new line of Size 0 and 1 magnetic starters that is 42% smaller than previous open forms and is built to the new NEMA ratings. The new starters with "snap-slide" construction provide easier inspection and maintenance because principal components snap or slide together. Completely new and radically different in design, this line of starters offers:

- wrap-around cover with spring latch—easily removed without tools for inspection
- removable sides for greater accessibility
- straight-through wiring speeds installation
- pressure-type terminals make wiring easy
- vertically-slanted contacts give higher tip pressure, reduce possibility of contact welding
- long life "kick-off" spring provides clean break of contacts in any mounting position
- strongbox coil with Mylar* insulated start wire for longer coil life
- overload relays adjustable for ±15% of trip setting
- nine field modification kits for greater flexibility
- new maximum NEMA ratings up to 7½ hp at 220 volts and 10 hp at 440 volts

Two additional features of the new magnetic starter are extremely quiet operation and lower inrush requirements of the coil. Sound absorbing material around the magnet lowers the operating noise level. Lower coil inrush current will allow you to use a 47% lower rated control transformer with this starter—saving you money and mounting space.

Size 0 and 1 General Electric starters are available now in non-reversing, combination, reversing and multispeed forms. Contact your nearest General Electric Sales Office or Distributor, or write Advertising Section 731-13 for the 20-page bulletin describing the line. Ask for GEA-6611. General Electric Company, Bloomington, Illinois.



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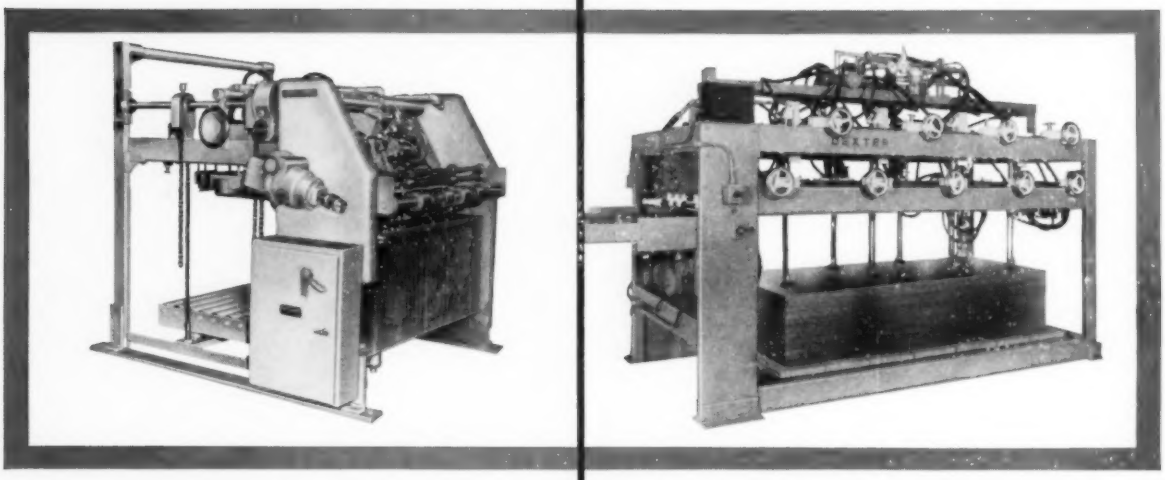

Dexter 9000# H.D. Feeder runs at speeds up to 9000 sheets of tin plate per hour. Used primarily in most major metal decorating plants.

Dexter Plate Feeder handles metal plates up to 3/16" thick and a maximum size of 4-by-12 feet. Used in many plants for feeding descaling equipment.

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Dexter Feeders are available in over a hundred sizes, speeds and load capacities to suit individual machine or process requirements. Sheet sizes range from 14 x 14" to four by twelve feet...sheet thickness from .006" to 3/16" or more...load capacities from 6,000 to 30,000 pounds ...and speeds from 600 to 9000 per hour!

Thousands of Dexter sheet handling machines are in use today in container plants, electrical equipment factories, appliance manufacturing plants, in tin plating lines, printing and binding companies, and in a wide variety of other industries...speeding up production efficiently and economically.

If you need help with your sheet feeding problems—check with Dexter. Their combination of engineering experience and equipment flexibility may be the solution for increasing your productivity.

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New Fields to Conquer

IN the development of automated production facilities, analysis indicates three key phases must be carefully integrated: (1) the processing steps or production machines; (2) the handling arrangement or devices; and (3) the automatic control system. Although favorable results have been widely attained through extensive development of the first two phases, today considerable emphasis must be accorded the third. The automatic control system holds the answer to greatly improved products and production efficiency, offering the most effective means for reducing loss and waste in materials and time.

More intensive study of the practical methods for control of operations will reveal tremendous untapped potential. In the category of control the part played by instrumentation must be adequately recognized. Pointing up this fact are the comments of Ralph V. Coles, assistant vice president, Fielden Instrument Div., Robertshaw-Fulton Controls Co., in a recent talk in Pittsburgh:

"There is not a single industry in the industrial classification that is not now using instruments and controls to some degree. It is an absolute certainty that more could be used in the engineering industry, process industry and miscellaneous manufacturing industries. It is not going to be necessary to have long runs of a given product to justify some degree of automation. Even specialty manufacturers have to increase productivity."

The specialized editorial section included in this issue of AUTOMATION has been developed in cognizance of the instrumentation phase of automatic control. Along with a complete study of one of the fundamental factors, flow control, some of the systems approaches to instrument control are covered. These articles indicate only a few of the many advanced applications now possible.

Control today is still in its infancy in the manufacturing and processing industries. Study of automation problems from the triple-phase standpoint appears to offer returns of significant economic value. The vital control elements are available. Know-how and ingenuity will reveal broad new fields to conquer.

EDITOR

AUTOMATION

INSTRUMENTATION AND CONTROL

In May AUTOMATION presented a group of articles on evaluation of production equipment. In this issue the control category is given specialized treatment. Control is a broad subject in itself with many areas to be considered. The following four articles reveal pointedly the role instrumentation plays in the control of automated systems. *First* is a basic coverage of flow measuring devices—the key to process control. *Second* is a description of a viscosity control system—illustrated by its application in blending liquids and solids. *Third* is a discussion of signal transmission between measuring points and control points—electropneumatic conversion is described. *Fourth* is an article on an analog computing device used to provide optimal control. It is seen that instrumentation is often a vital link in the control of automated systems.

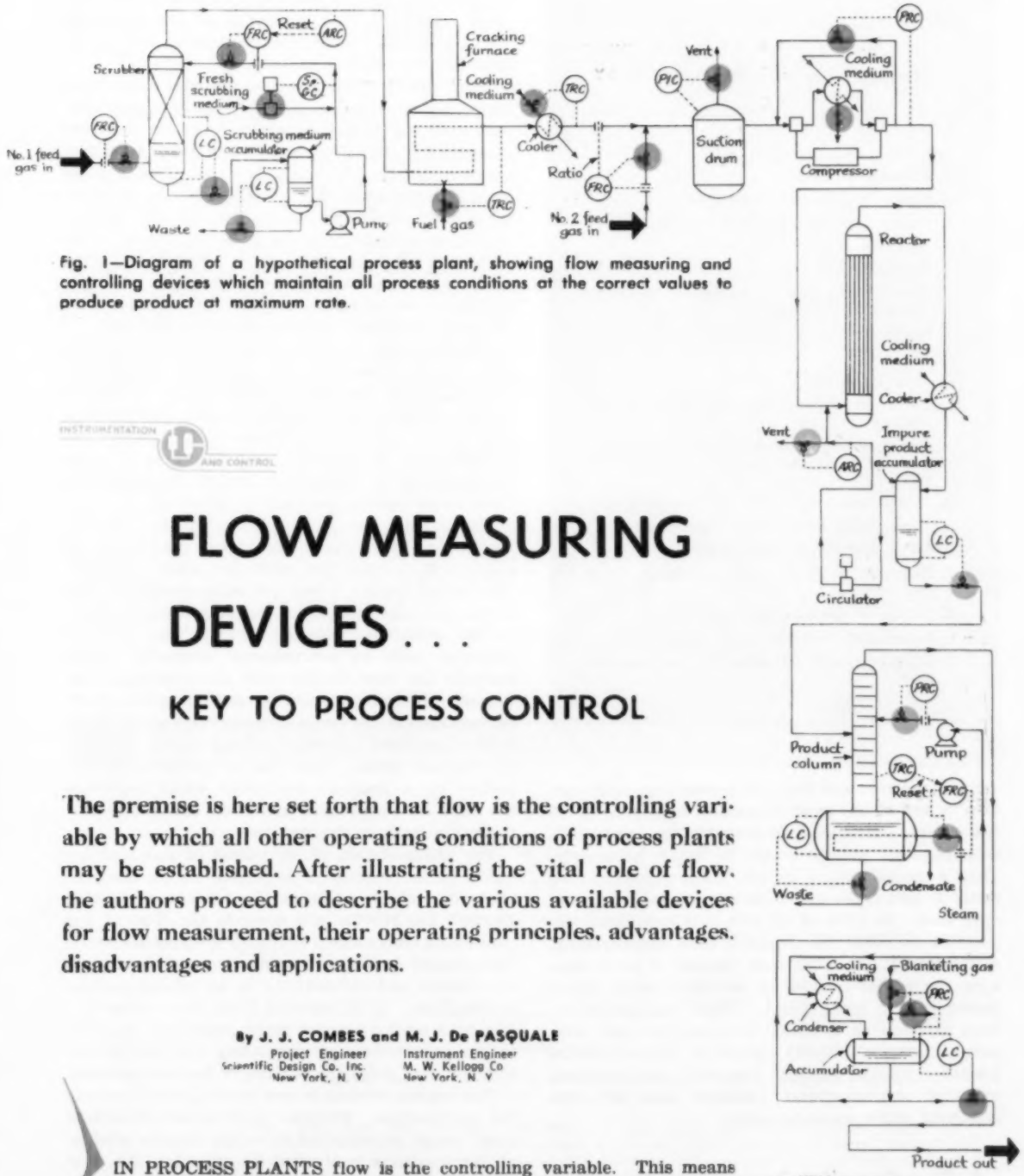


Fig. 1—Diagram of a hypothetical process plant, showing flow measuring and controlling devices which maintain all process conditions at the correct values to produce product at maximum rate.

INSTRUMENTATION AND CONTROL

FLOW MEASURING DEVICES . . .

KEY TO PROCESS CONTROL

The premise is here set forth that flow is the controlling variable by which all other operating conditions of process plants may be established. After illustrating the vital role of flow, the authors proceed to describe the various available devices for flow measurement, their operating principles, advantages, disadvantages and applications.

By J. J. COMBES and M. J. De PASQUALE

Project Engineer, Scientific Design Co. Inc., New York, N. Y.
Instrument Engineer, M. W. Kellogg Co., New York, N. Y.

IN PROCESS PLANTS flow is the controlling variable. This means it is the variable which, by being regulated or controlled, maintains all of the other process conditions at the values required to keep the plant producing product of the required purity at the maximum rate. In other words, all measured variables in addition to flow (composition, temperature, pressure, level, pH, specific gravity, density, viscosity, etc.) are actually controlled by regulating the flow of the process materials, the heating or cooling mediums, the vent gases, etc.

In addition to the control of process variables such as temperature, pressure, level, etc., the overall process control many times requires that flow be controlled directly as flow. Flow measurement, without control, is also required as an indication of process performance, for plant pro-

TABLE 1

Check List for Flow Meter Selection

1. Will it do the job (make the measurement under flow conditions)?
2. Initial cost.
3. Maintenance cost.
4. Ease or complexity of installation.
5. Range and/or rangeability of flow required.
6. Materials of construction.
7. Consumption of stream energy.
8. Space and support requirements (including piping configuration).
9. Range change requirements.
10. Availability.
11. Accuracy or reproducibility.
12. Correction factors required for changes in flow conditions.
13. Accessory equipment required to get measurement in the desired form to the desired location.
14. Utilities required to make instrument operate.
15. Compatibility with existing instruments.
16. Anticipated life of installation.
17. Frequency of measurement (continuous or intermittent).
18. Validity of operating principle.
19. History and reputation of the device.
20. Experience and reputation of the manufacturer.

duction records, and for cost accounting. Although flow is one of the most frequently measured of all the process variables it is probably the most difficult physical measurement to make accurately. This is demonstrated by the very multiplicity of methods and types of equipment available to measure flow. In spite of all this it is sometimes impossible to make the required flow measurement satisfactorily. It is difficult because it must measure the actual amount of material being transferred past a given point. Other measurements, such as those of intensity (temperature and pressure), location (level), physical characteristics (density, specific gravity, viscosity) and physical-chemical characteristics (analysis and pH) are relatively static measurements.

▶ Flow Controlled Process

Process control by regulation of flow may be illustrated by a description of the control system for a hypothetical process unit, *Fig.* 1. No. 1 feed gas is supplied to the unit under direct flow control. It flows upward through a packed scrubbing tower where it is contacted countercurrently with a liquid scrubbing medium. The scrubbed gas leaving the top of the scrubbing tower is analyzed by a gas analyzer for the presence of objectionable material not removed by the scrubbing medium. The analyzer resets the flow controller on the scrubbing medium in order to provide the correct flow to accomplish the required cleanup.

Since the scrubbing medium becomes diluted and less effective with use, a specific gravity controller and metering pump maintain it at the required strength by controlling the flow of fresh scrubbing medium to the circulating stream. The required level is maintained in the bottom of the scrubber by a level controller which controls the flow of scrubbing medium from the scrubber bottom to the scrubbing medium accumulator. Spent scrubbing medium is removed from the system by a level controller on the accumulator which controls the flow of spent scrubbing medium to waste disposal.

The scrubbed gas is sent to a cracking furnace where it is cracked to the required composition. The degree of cracking is controlled by a furnace outlet temperature controller which controls the flow of fuel gas to the furnace. The cracked gas is cooled to the required temperature in a cooler by means of a temperature controller regulating the flow of cooling medium to the cooler.

No. 2 feed gas is blended with the cracked, cooled No. 1 feed gas in the correct proportion for reaction by a ratio flow controller which measures the flow of the No. 1 feed gas and controls the flow of the No. 2 feed gas. The blended gas stream flows to the compressor suction drum. This drum is provided with an overpressure controller which controls the flow to the vent and eliminates the necessity of shutting down the scrubbing and cracking systems in the event a temporary upset in the reactor prevents it from accepting the normal flow of reactant gases. The reactor pressure is controlled by a pressure controller which regulates the flow of compressed gas from the compressor discharge back to the suction.

The accumulation of an excess of non-reacting inerts in the reactor is prevented by an analyzer controller which analyzes the stream circulating through the reactor and controls the flow of gas containing inerts which is vented to the atmosphere. The product in the circulating stream is condensed in a cooler and accumulates in an impure-product accumulator. It is removed from the reactor system by a level controller which maintains the level in the accumulator by regulating the flow of impure product from the bottom of the accumulator.

The impure product is sent to the product column for purification. Material up to a certain boiling point range is vaporized from the impure product at temperatures controlled by resetting the controller for steam flow to the product column kettle. The flow of unwanted residue to waste disposal is controlled by the kettle level controller which regulates the residue flow from the kettle bottom. Pressure in the column is controlled by a pressure controller which regulates the flow of inert blanketing gas into or out of the condensed overhead accumulator. Reflux to the column is under flow control and the flow of pure product to storage is controlled by a level controller on the overhead accumulator.

This example illustrates how regulation of the one variable—flow—can control analysis, level, pressure, specific gravity and temperature in a process plant.

▶ Application Considerations

There are a number of separate considerations which, if carefully evaluated, lead the instrument application engineer to make a wise choice of flow devices. Several of these are listed in TABLE 1.

Although, at the present time, the great variety of flow measuring elements available afford an adequate means of measurement for almost any existing application, new developments in chemical and petroleum processes, in the missile program, in atomic energy, in medicine, etc., will call for new methods of flow measurement. The new methods will be necessary to cope with the new conditions imposed which will require flow measurement at extreme limits of flow quantity (very high and very low), at very high and very low temperatures and pressures, and of substances of unstable state and extreme physical properties.

There is also need for improved methods and equipment for flow measurement for today's applications. New flow elements are needed which will meet more of the following conditions:

1. Greater accuracy and reproducibility.
2. Less permanent energy loss.
3. Less affected by physical properties of the fluid flowing such as viscosity, presence of entrained material, changing state, density, etc.
4. Easier and less expensive to fabricate.
5. Less maintenance required.
6. Easier to install (no straight run requirements).
7. Greater rangeability (ratio of the maximum flow to the minimum controllable flow).
8. Can be accurately calculated—no calibration necessary.
9. Linear relationship between actual flow and measurement signal produced.

For the present flow measuring elements there are available a complete series of transmitters, receivers, indicators, recorders and controllers which have the ability to interpret the measurment signals, transpose them into a useful carrier such as air pressure or electrical current or voltage, transport them to convenient locations and, in the case of controllers, cause the necessary corrective actions. Improvement and development of these supplementary components will undoubtedly keep pace with the improvement and development of the measuring elements.

In order to choose the best device for a particular flow measurement application it is important to know the basic design features, advantages, and disadvantages of the available instruments. These are outlined in the accompanying pages under 12 broad categories.

1 VARIABLE HEAD FLOW METERS

The variable head meter provides an inferential type of flow measurement in that it measures the change in pressure head due to a change in velocity, thus inferring flow from differential pressure. Because variable head meters obtain their measurement by detecting changes in pressure head due to changes in velocity, they follow the basic relationship expressed in the equation:

$$Q = A\sqrt{2gh}$$

where Q is flow, A is line cross-sectional area, g is a gravity constant, and h is differential pressure head.

This leads to three basic disadvantages, namely:

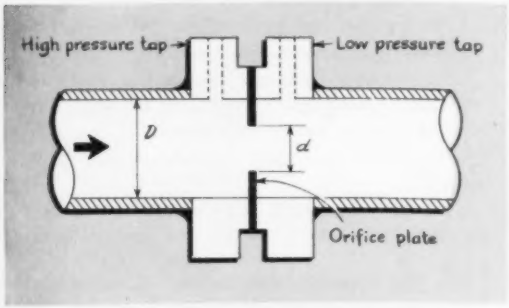
1. The non-linear relationship between measured differential and flow makes it impractical to measure (with any reasonable degree of accuracy) flows less than 30 per cent of maximum instrument capacity. This means a flow rangeability of about 3 to 1.
2. Generally cumbersome and inaccurate means for integrating (or totalizing) flows over a period of time.
3. For pulsating flow, any damping device introduced into the measuring system suppresses the differential measurement rather than the flow, thus introducing inaccuracies.

Lead lines from the process connections to the manometer in a variable head meter installation require proper arrangement to prevent vapor pockets in liquid flow and improper condensation in vapor flow. In addition, it is necessary to protect the material in the lead lines from adverse temperature effects such as freezing, gumming, setting, and boiling. When it is undesirable for the process fluid to contact the instrument, connections for the introduction of a purge material are often provided.

While a manometer is isolated from a process with block valves and can be easily removed for servicing, the differential producing device cannot readily be made accessible without shutting down flow and bringing the process pressure to atmospheric.

In spite of the apparent disadvantages, variable head meters remain the most popular and versatile single type of metering element for a flow application. They accommodate a relatively wide range of materials, flow quantities and line sizes, and they offer attractive advantages in accuracy, availability and economy.

ORIFICE PLATE



This device is a thin, sharp-edged plate, perpendicular to the direction of flow, with a hole (or bore) whose diameter is generally maintained between 0.2 and 0.7 times the line diameter. The data available are generally applicable to this range of bore to line diameter ratios (d/D or β) and for line sizes 2 inches and greater. For β ratios less than 0.2 or greater than 0.7, and for line sizes less than 2 inches, each installation requires individual calibration. The exact bore diameter can be calculated by the user for a given line size, flow quantity, flow condition, and differential produced. The various coefficients necessary for a precise orifice plate calculation have been determined experimentally over a long period of time and are available in flow calculation manuals.

Concentric orifice plates can be used for the measurement of most single phase fluids. Fluids containing suspended solids can be measured by means of eccentric or segmental orifice plates. For gases containing small quantities of entrained liquids (wet steam, etc.) a small drain hole is generally provided at the bottom of the line to prevent liquid buildup on the upstream side of a concentric plate. Likewise, for liquid streams containing small quantities of vapor a vent hole at the line top affords the same protection against vapor buildup. Obviously, these drain and vent holes will not be required in vertical orifice runs.

Applications

The application of orifice plates is extremely broad, covering all flow measurements except those under extreme conditions of high viscosity, low static pressure, poor physical condition of the fluid (solids, dirt, heavy slurries, sewage), and space limitations.

Although flange taps are most commonly used (1 inch upstream and 1 inch downstream of the orifice plate), two other arrangements are sometimes utilized to special advantage. Vena contracta taps (approximately 1 diameter upstream, and downstream at the point of minimum static pressure) produce the maximum differential for a given flow and are therefore slightly more accurate than flange taps. Obviously the orifice bore cannot be changed in a given installation since the vena contracta location varies with bore size. Pipe taps (2½ pipe diameters upstream and 8 diameters downstream of the orifice plate) measure the permanent pressure drop so that, for high velocity flows, manometers of practical differential range can be utilized. However, the lower differential involved naturally yields a less accurate measurement than either the flange or vena contracta taps.

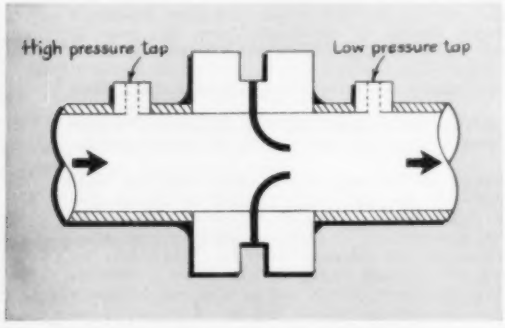
Advantages

1. Easy installation between flanges.
2. Low manufacturing cost.
3. Can be precalculated by the user from adequate data available.
4. Little or no limitation on the materials of construction.
5. Lends itself to increases in capacity. (For larger flows the original plate can be rebored.)

Disadvantages

1. Requires a straight run of pipe the length of which is dependent upon the nature of the fittings upstream and the piping configuration.
2. Low recovery of differential produced, dependent upon β ratio as follows: Unrecoverable head = $h(1-\beta^2)$, where h is the differential produced across the plate.
3. Subject to inaccuracies as the sharp upstream edge wears.
4. Requires special data for segmental and eccentric plate calculation.
5. Inaccurate where viscosity is high—precise calculation is generally valid only for Reynold's numbers down to about 15,000 or 20,000.
6. Impractical for measurement of flows in systems with low static pressure such as blower discharges, vents and vacuum systems, because small differentials produced in these systems cannot be accurately measured.

FLOW NOZZLE



This element is a smooth, convergent nozzle, with a hole whose diameter is generally betwen 0.25 and 0.7 of the line diameter (d/D or β = 0.25 to 0.7). While the sizing of the nozzle depends upon a precise calculation similar to the orifice plate, generally the manufacturer, not the user, performs the flow calculation for a particular nozzle with the data he possesses.

Applications

Flow nozzles can be used for the same applications as orifice plates, though not so economically or conveniently. Usually they are used for higher capacities, or where immunity to high viscosity is required, or for measuring flows of slurries containing high concentrations of entrained solids.

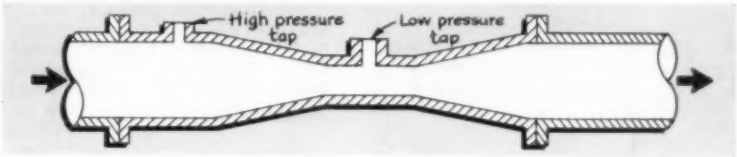
Advantages

1. Easy installation between flanges.
2. Better accuracy than an orifice plate for large β ratios.
3. Handles dirty fluids or heavy slurries easily.
4. Better accuracy than an orifice plate for high velocity flow.
5. Pressure recovery is better than for an orifice plate having the same β ratio.
6. Less susceptible than an orifice plate to inaccuracies due to wear.

Disadvantages

1. Expensive to fabricate.
2. Difficult to remove from the line.
3. Capacity increase cannot ordinarily be made by modifying the existing nozzle.

VENTURI



This is a differential pressure producing element consisting of a relatively short convergent section, a shorter throat section (the point of minimum diameter), and a relatively long divergent section. Upstream (or high pressure) taps are located just upstream of where the convergence begins, and the throat (or low pressure) taps are located in the throat at the point of minimum diameter. The throat to pipe line diameter ratio (d/D or β) is usually between 0.25 and 0.75.

Calculation is generally carried out by the manufacturer, since minor variations in design among various manufacturers present corresponding variations in the numerous factors involved in a precise calculation. Hence, two manufacturers can actually arrive at two different throat diameters for the same flow conditions.

Two basic variations in form are used. The long (or Herschel Standard) form has an entrance section with an approximately 20-degree included angle and an exit section with an approximately 7-degree included angle. The short form has a 20-degree entrance section and an exit section slightly less than 20 degrees.

Applications

Venturis are most often used, cost permitting, for measuring extremely large flows in large systems such as city water supplies and sewage lines; for measuring total gas or air streams to processing units; for slurry-like materials; and where accurate flow measurement must be made with a minimum of energy loss.

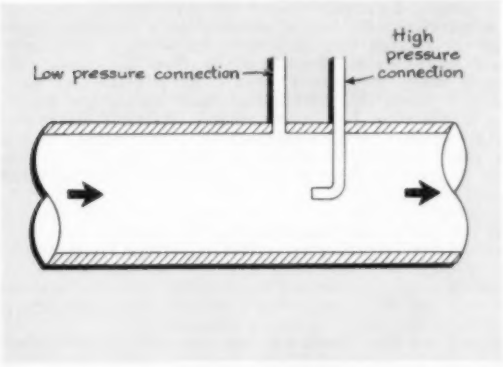
Advantages

1. High accuracy; probably the most accurate of the pressure differential type flow elements when properly calculated, manufactured, installed and calibrated.
2. Excellent pressure recovery due to the smooth gradual profile resulting in a minimum of turbulence losses—up to 85 per cent recovery of measured differential is possible.
3. Accurate where high d/D ratios are required.
4. Resists wear due to abrasion because of its smooth profile.
5. Used effectively to measure flow of materials containing entrained solids.
6. Can measure large flows in large lines.

Disadvantages

1. Costly and difficult to fabricate.
2. Awkward to handle and install due to its size.
3. Difficult to modify for major changes in flow range.

PITOT TUBE



This is an arrangement of two pressure taps in a flowing stream such that the low pressure connection (located perpendicular to the flow path) measures the static head only, and the high pressure connection (facing directly into the flow path) measures the total of static and velocity head. While the same basic laws of conservation of energy apply to the measurement of flow with a pitot tube, its measurement is an indication of velocity at one point only in the flowing stream, as opposed to the flow elements which consider energy conversion of the total stream. Thus flow is a function not only of the differential pressure obtained by means of the pitot tube but of its location in the stream as well. To obtain the average stream velocity v, and thereby flow Q, it is necessary to traverse (scan the flow stream across the pipe) with the pitot, measuring the differential at various points and obtaining a velocity profile. With the average stream velocity thus determined flow is easily obtainable from the relation $Q = Av$, where A is the line cross-sectional area.

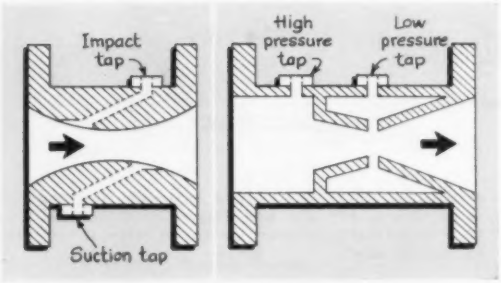
Advantages

1. Practically no energy consumption, becoming less (percentagewise) in the larger lines.
2. Simple installation; requires relatively small connection for insertion of thin element.
3. Same element can be applied to measurement of flow in a wide range of line sizes.
4. Inexpensive to fabricate.
5. Easy to install for temporary service.

Disadvantages

1. Relatively inaccurate.
2. Unsuited to materials containing solid entrainment.
3. Traversing sometimes difficult or impossible in very large lines or in installations where clearances are limited.
4. Unsuited to low velocity flows where differential pressure is too low to measure with standard industrial instruments. (This disadvantage can be partially overcome by the use of modified pitot tubes such as the *multiplying type* in which the static connection faces directly downstream, thus adding an additional suction head to the measured differential, and in the *pitot-venturi type*, in which a small venturi-shaped shield is provided around the connections so that the impact and static pressures are measured at the point of highest velocity, thereby creating a higher differential.)

FLOW TUBE



The flow tube is an impact-type head meter, inner surface of which is equipped with two sets of pressure taps. One set, the impact taps, faces upstream; the other set, the suction taps, faces downstream. Since both sets of taps are located in sections of equal diameter, the differential developed is a function of velocity head rather than static head. A second type of flow tube, utilizing somewhat different design features than those mentioned above, is available. It consists of a piece whose inner surface is made up of a short, straight, inlet section terminating with an abrupt decrease in diameter, or "inlet shoulder." The high pressure tap is located tangent to the inlet shoulder and measures the line static pressure plus a slight impact pressure. This is followed by a conical restriction and a diverging outlet separated by a narrow annular gap called the "slotted throat annulus." The low pressure tap connects with the annular throat slot and measures the minimum static pressure due to the increase in velocity through the flow element. Sizing is done by the manufacturer who generally must furnish a calibration curve based on test data.

Applications

Because flow tubes show the lowest permanent head loss of any standard differential producing flow element which measures the entire stream (as opposed to the point measurement of a pitot tube), it is most suited to low static pressure applications where it produces a differential sufficient for measurement without an ensuing permanent loss of a high percentage of the static head.

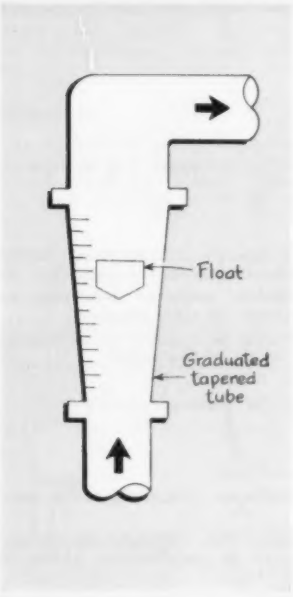
Advantages

1. Small space required for installation.
2. Low permanent losses.
3. Symmetrical construction (for the first type mentioned) makes this tube easily applicable to two-way flow measurement.

Disadvantages

1. Some unpredictable inaccuracy of measurement with variations in upstream piping configuration.
2. Velocity head sampling at the wall of a line or restrictor is questionable.
3. Higher initial cost than the basic orifice plate due to complexity of construction.
4. Unsuited to dirty material since clogging of taps can prevent accurate differential measurement.

2 VARIABLE AREA FLOW METERS



The variable area meter provides an inferential type of flow measurement in that it measures the change in flow area necessary to maintain a constant differential head for variations in flow rate.

Basically, a variable area meter consists of a vertical tapered tube, narrow at the bottom (the inlet end), in which a float moves upward as flow increases or downward as flow decreases. The tube is frequently made of glass so that float position can be determined visually. Since the differential head across the float in a variable area meter must remain constant (it being a direct function of the float weight), it is relatively easy to produce a taper such that the float position is almost a linear function of flow. Meters come in a great variety of tube diameters, lengths, tapers, float weights, and shapes.

Generally, sizing is done by the manufacturer from the data he possesses on his particular equipment and is based on flow quantity and flow conditions. Unlike the orifice or venturi which is often fabricated to a specific bore or throat size, the variable area meter, when it is a combination of standard component parts, is "selected" rather than "sized," since the capacities available from the different combinations of elements vary in small increments.

The widespread use and continual new applications of variable area meters have led to the development of a line of accessory components including: (1) Magnetic following devices for use when the measurement of float position is other than directly visual; (2) complete line of pneumatic and electric transmission devices, and (3) built-in dashpot devices for minimizing pulsation.

Installations of variable area meters often permit the use of block and bypass valving because there are no straight run requirements. This enables the device to be easily cleaned, have its range modified, or even be completely replaced without shutting down the process.

Applications

Variable area meters enjoy a wide range of application in process measurements, especially in the handling of difficult materials such as sulfuric and hydrochloric acids, chlorine, slurries, pulp, and many liquid food products. In the field of auxiliary measurement, variable area meters of extremely simple design are used for small air and gas purge streams and for oil and chemical bleeds.

Advantages

1. No external lead lines are required.
2. Float position can be observed directly or by means of simple magnetically coupled indicators.
3. Uniform graduations enable reasonably accurate measurement down to 10 or 15 per cent of maximum instrument capacity, giving a flow rangeability of 10 to 1 as well as linear charts on receiver instru-

ment.

4. Small capacity changes can be accomplished by simple changes in float density or weight; larger changes may be effected by changing tubes but using same body and connections.

5. Inherent "flow-through" nature of the device and variety of connection arrangements enable handling of slurries and some dirty fluids since the instrument is self-cleaning.

6. In pulsating flow, averaging of readings gives a truer indication of actual average flow than averaging of readings taken by variable head meters.

7. No special upstream and downstream piping configurations are required.

8. Pressure drop (representing energy consumption) is relatively low. That portion of the total drop used for measurement is constant since it is a function of float weight and area. The remaining drop through the meter body due to friction varies, of course, with flow.

Disadvantages

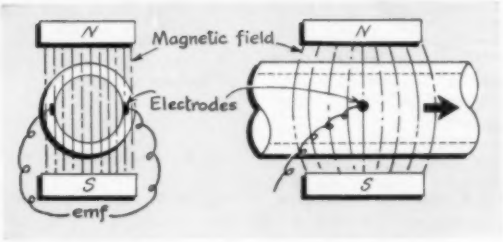
1. Expensive, compared to an orifice installation, in sizes over 2 or 3 inches. Compared to venturi tubes, flow nozzles and flow tubes, the cost disadvantage is not so great. Roughly, the cost of variable area meters tends to increase as the square of the pipe size.

2. Good accuracy in high viscosity flows requires special calibration, particularly at the low end of the instrument range where the Reynold's number may decrease to the 5000 to 10,000 region.

3. Because of the vertical tube arrangement, installation of variable area meters requires more pipe fittings than a variable head device.

4. Glass tubes are fragile and subject to frequent breakage. Etching of glass can become serious when handling certain materials. Dirty or opaque fluid metering requires float extension devices to make indication possible, causing meter to lose some of its basic simplicity. Metal tube types with magnetically coupled indicators are more expensive.

3 MAGNETIC TYPE FLOW METERS



The magnetic flow meter is a volumetric metering device the operation of which is based on Faraday's law of electromagnetic induction. This states that an electromagnetic force, or voltage, is induced in a conductor which is moved through a magnetic field; the voltage is induced in a plane which is mutually perpendicular to the direction of the motion of the conductor and the magnetic field. The electromagnetic flow meter consists of a length of tube or pipe through which material flows, an electrical coil to produce a magnetic field in a direction perpendicular to the flow, and a set of electrodes mounted practically flush with the inside of the flow element and located at right angles to both the magnetic field and the flow. When material flows, a voltage is induced in the flow stream which is proportional to the average velocity of the liquid, the strength of the magnetic field, and the distance between the electrodes. For a given meter the latter two are fixed values; therefore, the volumetric flow rate, being a function of average velocity and flow area, is directly proportional to the induced voltage.

Magnetic flow meters are made in sizes as large as 24 inches in diameter. Tube elements are constructed of non-magnetic materials or, where size or strength requires the use of standard pipe, the interior walls can be lined with a suitable non-magnetic material. Remote indicators, recorders, totalizers and other accessory components capable of measuring and interpreting electrical signals complete the magnetic flow meter systems.

Applications

Magnetic meters are suited to the flow measurement of difficult materials such as paint and varnish, slurries, high viscosity and non-Newtonian fluids, pastes, paper pulp, food and dairy items, rubber and latex and rayon and other chemical products. However, application in the petroleum field is limited since no refined hydrocarbons are conductive and not all natural crude oils have sufficient conductivity for this type of measurement.

Advantages

1. Pressure loss through the element is the same as an equivalent length of pipe, there being no obstructions to flow.

2. The element can handle many materials capable of flowing through pipe normally, regardless of solids or dirt content.

3. Can be arranged easily to measure two-way flow.

4. Changes in temperature and viscosity do not appreciably affect the accuracy of measurement.

5. Buildup of deposits on the interior of the tube is not as serious as it would be say, for a venturi meter handling the same material.

6. High accuracy, flow rangeability, fast and linear response, depending upon the associated components used.

7. Measurement is unaffected by changes in the velocity profile.

Disadvantages

1. Cost is high compared to the more conventional flow measuring devices.

2. Not all materials have sufficient electrical conductivity to be metered electromagnetically. Generally the conductivity should be at least 200 micro-mhos for small meters and 50 micro-mhos for 8 inch and larger meters.

3. Maximum ambient temperature is about 135F.

4. Temperature of flowing fluid is limited by the lining material to about 400F.

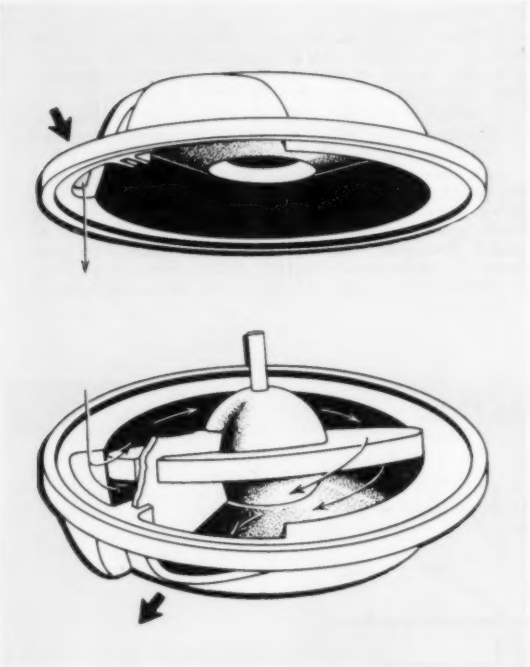
5. Large meters, 10 inches and up, require 230-volt power supplies.

6. The material metered must be a homogeneous conductor.

7. Special consideration is required to obtain explosion-proof equipment for hazardous areas.

8. Gases cannot be metered.

4 POSITIVE DISPLACEMENT FLOW METERS



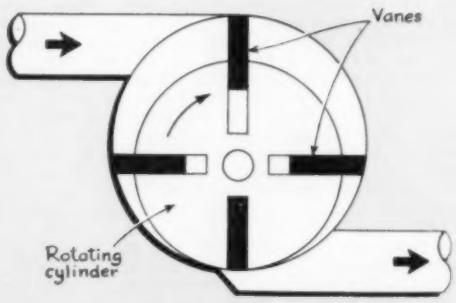
Unlike the inferential types of flow measuring devices mentioned thus far, positive displacement meters are mechanical devices whose internal elements move by virtue of the energy imparted by the flowing stream. Because the internal cavities are designed to contain specific quantities of the flowing material, each measuring cycle described by the motion of the internal elements corresponds to a fixed volume of material flowing through the meter body. The flow quantity is then determined by merely counting the number of measuring cycles.

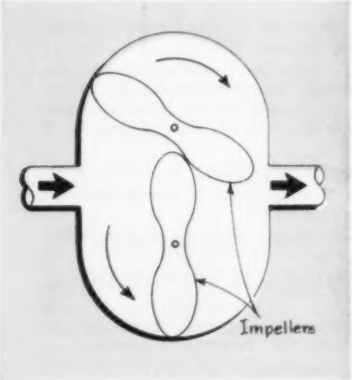
NUTATING DISK

This liquid flow meter consists of a disk with a ball at its center resting in a socket. The disk is enclosed in a chamber into which liquid enters, impinges on the disk, causing it to rock or nutate, thus permitting the liquid to flow around to the outlet side of the chamber. Each nutation cycle transfers a discrete volume of liquid through the chamber. The cycles are transmitted to a counter at the top of the meter by a pin extension in the ball operating a gear train and counting mechanism. The simplicity of design and construction accounts for its low cost and minimum maintenance requirements, making it the most widely used of the displacement meters available.

ROTARY VANE

In this meter design the body consists of a cylindrical chamber containing a smaller, rotating, eccentrically-mounted cylinder. The cylinder has slots equipped with spring-loaded sliding vanes which maintain contact with the chamber wall. Material enters the compartments at the point of greatest space between the cylinders, causing the inner cylinder to rotate. It becomes confined as the next vane passes the inlet port, and is carried around to the outlet port and is discharged by the decreasing volume of the confining compartment. A count of the cylinder rotations indicates total flow.



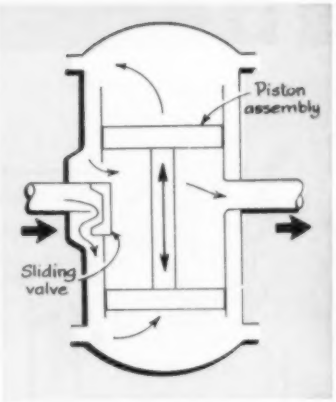


ROOTS

This meter consists of two lobed impellers which mesh and rotate. The lobes are shaped to provide continuous contact between a housing and the lobe ends, and also between the lobes themselves. In a somewhat similar manner to the rotary vane meter, the material, usually gas, is trapped between the close fitting lobes and the chamber, carried around and ultimately discharged. A count of the impeller rotations indicates flow.

PISTON

There are many variations of the piston type meter. A common type is the two cylinder version shown in the accompanying figure. The material enters through a properly positioned slide valve, exerts a driving force on the exposed piston which drives the second piston, forcing its material toward the outlet. As the sliding motion proceeds, the slide valve repositions to allow the entering material to act upon the second piston, thus driving the original material toward the outlet. The pistons are connected to a crank arm which operates the slide valve so it opens and closes at the proper points in the reciprocating measuring cycle. The crank arm also operates the counting mechanism to reflect flow through the meter.



Applications

Positive displacement meters find their widest application where integrated flows are required such as home metering of utilities to determine charges, barge and truck loading of products to be sold, and transferring materials from process units to storage facilities. In batch processing these meters can often be arranged to shut a solenoid valve after the passage of a preset quantity of material. For rate-of-flow measurement, positive displacement meter movements can be arranged to drive small electrical generators in addition to the usual totalizing registers.

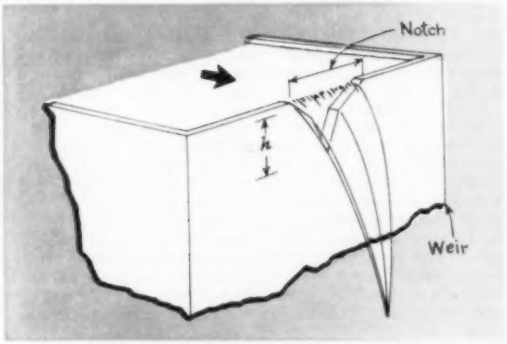
Advantages

1. Accuracy is high, even for measurement of low flows.
2. Installation is simple, requiring only straight-through connection in the line.
3. Meter naturally integrates, requiring no additional devices to accomplish this function.
4. Where tolerances are properly maintained, volumetric measurement is not seriously affected by variations in density, viscosity, or pressure.
5. Small, compact design of most types makes them easy to handle, yet rugged enough to withstand reasonable physical abuse.
6. Totalizing registers read directly in digital values, eliminating the necessity for interpreting an analog measurement.
7. No straight run of upstream or downstream piping is required.

Disadvantages

1. High cost in large sizes. Displacement meters for industrial liquids, water, oils, and chemicals are generally limited to the ½ to 6-inch size range.
2. Maintenance is high because of the relatively large number of moving parts.
3. Solids or abrasive bearing liquids cannot be handled satisfactorily since clogging and wear would occur.
4. As wear of the moving parts progresses, slippage increases and destroys accuracy.
5. For a given meter, accuracy is less at low flows than at high flows.
6. The possibility of entrained air or vapor in a liquid flow stream necessitates the use of a vapor trap upstream of the meter. If this is not furnished, an error proportional to the amount of entrained vapor occurs.
7. It is inconvenient and sometimes difficult and expensive to obtain instantaneous flow rates with this type of meter.

5 WEIR TYPE FLOW METERS

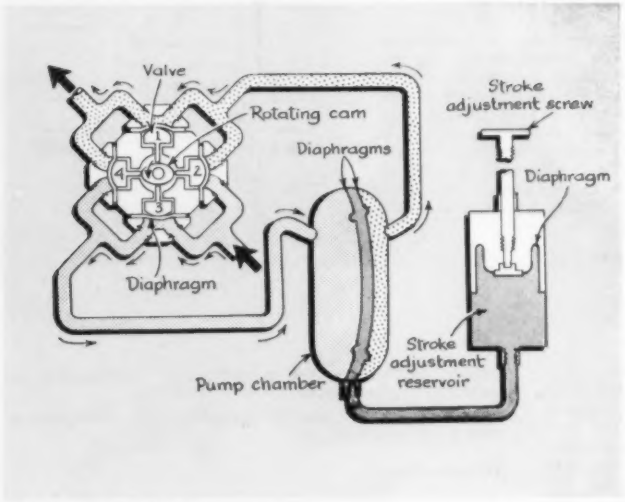


In process instrumentation most flow measurement involves material moving in closed pipe. However, there are many endeavors requiring moderately accurate flow measurement of large systems of open channels such as streams and canals used in irrigation, sewage treatment and utility work. Such measurements are made with weirs which are merely obstructions in the flowing stream over which the material, usually water, flows. The weir plate is a flat, thin partition containing a characteristically shaped cutout or notch through which the material passes. It is located so that its face is at right angles to the direction of flow and may be either directly in the natural flow channel or in an auxiliary weir box, or stilling chamber, in which the flowing material is permitted to reach suitably low velocities before approaching the plate. The stilling chamber also serves to settle out undesirable material.

Three notch varieties are commonly used—rectangular, trapezoidal, and V-notch. The V-notch most often has 60 and 90-degree angles for both high sensitivity and rangeability. A common trapezoidal version known as a Cipolletti Weir has side slopes of one horizontal to four vertical. Each notch shape has its own characteristic equation for determining flow through the weir, based on a constant (depending upon type) and the head of liquid on the weir (the vertical distance from the upstream liquid surface to the crest, or bottom edge of the notch). Level floats or other devices measure the head of liquid from which flow may then be calculated.

The design, installation, operation and maintenance of weirs and flumes can be found in most comprehensive metering manuals and hydraulic texts.

6 METERING PUMPS



Courtesy, Milton Roy Co.

Metering pumps are positive-displacement, controlled-volume pumps that both measure and control flow. With these pumps flow is controlled by varying the length of the stroke, the stroke rate, or both. An example of when both methods of control would be used is in the control of pH of a flowing material by injecting a small amount of acid or base. The final pH of the stream would control the stroke of the pump and the flow rate of the stream would control the speed of the pump. This would tend to prevent an upset in the final pH in the event the stream flow rate changed. Since the pump discharges a fixed amount of fluid for each stroke of a given length, knowledge of the stroke length and stroke rate indicates the rate of flow. The flow may be integrated as a product of the stroke length and total strokes.

There are three main types of metering pumps—piston, diaphragm and combination piston-diaphragm. The latter type may employ oil pressure developed by the action of a piston to actuate a diaphragm and pump the fluid.

Applications

Metering pumps are used where flow must be both measured and controlled and are usually thought of more as flow controllers than flow measuring elements, although a flow measurement can be easily obtained from any metering pump.

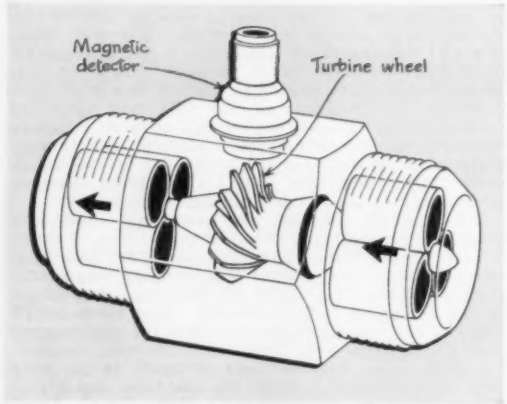
Advantages

1. The same instrument is both the measuring means and controlling means.
2. It is highly accurate. (Manufacturers claim better than ±1 per cent.)
3. It can operate over wide temperature and pressure ranges.
4. It can measure and control extremely small flows, as low as 4 milliliters per hour.
5. Can be fabricated from many materials to resist corrosion.
6. It can measure and control the flow of many difficult-to-measure substances such as slurries, molten metals, or very corrosive materials.

Disadvantages

1. Since it is a pump and therefore causes flow, it cannot be used to measure flow without at the same time controlling it.
2. It cannot be used in the high flow ranges above a few hundred gph.
3. Its flow-causing and controlling feature adds to its expense as a flow measuring element.

7 TURBINE TYPE FLOW METERS



The turbine meter is a compact, in-the-line device containing a turbine wheel in the flowing stream which revolves at a speed proportional to the fluid velocity. The axis of rotation coincides with the longitudinal axis of the flow element and line in which it is installed. A small coil assembly, just outside of the body proper, serves as a pickup device for two basic types of turbine meters. In one, a small permanent magnet is imbedded within the body of the turbine rotor, polarized at right angles to the axis of rotation. As flow causes the turbine to rotate, pulses are generated in the coil assembly by the action of the moving magnet. In the second type the turbine blade tips themselves cause electrical impulses to be induced by interrupting the magnetic lines of flux as each blade tip passes the coil assembly. The total number of pulses measured reflects the integrated flow through the sensing element. The frequency of the pulsating signal is an indication of the instantaneous flow rate. Hence, either electronic counters or frequency converters are used in conjunction with the elements, depending upon the nature of the measurement desired.

Applications

Turbine meters, together with an assortment of indicating, recording, and totalizing accessories, can be used for measuring flow of oils, chemicals, liquid oxygen in rocket research, liquors in paper processing, and in aircraft applications.

Another type of turbine meter, of moderate ac-

curacy, utilizes the same principle of operation without an electrical pickup. Instead the turbine drives a totalizing register through a worm and pinion or a magnetic coupling. This type is used in large water distribution systems. It can measure flows up to 60,000 gpm in line sizes up to 72 inches. It also can be used as an immersion device in large irrigation canals.

Advantages

1. Good for high pressure flow measurement; standard units are available for 5000 psi applications.
2. Element output is approximately linear over a 10 to 1 flow range.
3. High accuracy and repeatability over a reasonable portion of the flow range.
4. Requires little upstream straight-run of pipe (nominally 4 or 5 diameters).
5. Low mass rotors and electrical pickups produce very short response times to changing flows.

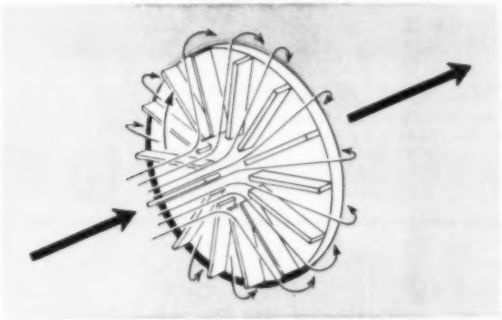
Disadvantages

1. Highly abrasive flowing media can shorten bearing life.
2. High viscosities, usually above 5 centipoises, diminish the linear range of measurements, the effect being more pronounced in the smaller meter sizes and, naturally, at the low end of the instrument range.
3. Above 400 or 500F, pickup coil assemblies must be protected from high temperatures by either forced air or water cooling.
4. Severely pulsating flows, water hammer, or other sudden shocks on the unit are undesirable. If they are unavoidable, element calibration must be verified frequently.

8 MASS FLOW METERS

The mass meters mentioned here measure true mass flow as opposed to volume flow with gravity correction and, as such, are completely immune to changes in pressure, viscosity, temperature, density, and compressibility.

CORIOLIS METER



The Coriolis flow meter bears a striking resemblance to a centrifugal pump. Material enters the "eye" of the unit, encountering a vaned impeller. The material is deflected from its axial path and proceeds in a radial direction between the impeller vanes. As the material moves further and further away from the center of rotation its tangential velocity increases, constituting a tangential acceleration known as "Coriolis acceleration." With the impeller rotating at a constant speed this acceleration will likewise be constant. Hence the force required to tangentially accelerate the flowing material is exactly proportional to the mass flow rate of that material.

Advantages

1. Will handle gases, liquids, foams, and slurries.
2. Since energy is imparted to the flowing stream this device can produce a pressure rise rather than a drop.
3. Response is fast and linear.
4. Adaptability to standard indicating, recording and controlling equipment.

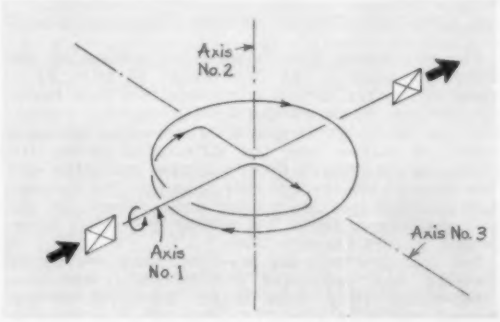
Disadvantages

1. Requires a high-accuracy, constant-speed drive.
2. Requires rotating seals.
3. Maintenance is high due to complexity of design.
4. Leakage occurs under adverse pressures and temperatures.

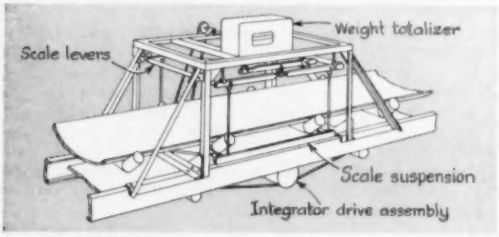
GYROSCOPIC METER

In a gyroscope, the end of the axle of the rotating gyro wheel always tends to move at right angles to any force impressed upon it. In the mass flow meter based upon the gyroscopic principle the gyro wheel is replaced by the flowing material arranged to move in a circular path. As the assembly is rotated at a constant speed about Axis 1, which is at right angles to Axis 2, the axis of rotation of the flowing material, the tendency for the assembly is to move about a third orthogonal axis, Axis 3. This tendency is similar to precession of a gyroscope. Since the precession motion is restrained, the torque produced can be measured and is directly proportional to the mass flow of the material.

Advantages of this device are the same as for the Coriolis meter except that response is slower, making it more suited for averaging of pulsating flows. Disadvantages are likewise similar although the more devious flow path places some limitation on the materials handled. Both devices yield high accuracy measurements and are available in various sizes (10 to 500 lb per minute). They can handle most gases, liquids and some solids mixtures.

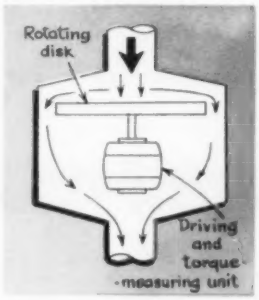


SOLIDS METERS



In addition to all of the various methods and types of equipment to measure the flow of liquids and gases, there is also equipment available with which it is possible to measure the flow of solids.

Flow of solids may be measured on a moving conveyor belt. The weight of material on a fixed area of the belt is measured by passing the belt over a weigh bridge of a fixed length. The bridge is supported on a scale whose signal is transmitted to an integrating and indicating or recording instrument. The speed of the belt is also measured and the signal is integrated with the weight signal. The instrument is then able to indicate or record the rate of flow and indicate the totalized flow. This type of equipment is very accurate (some manufacturers claim 1/10 of 1 per cent) and is widely used in industrial, mining and agricultural installations for measuring the flow of such materials as coal, sand, grain, ore and pulp.

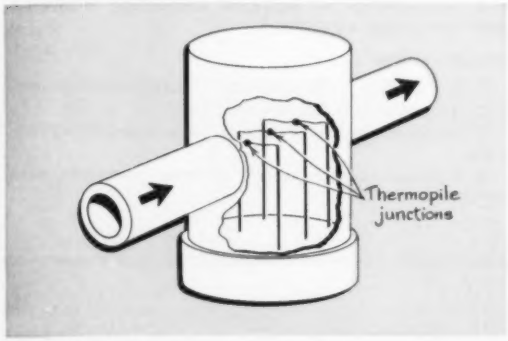


Another device measures the flow of solids dropped onto a rotating disk. The torque on the motor which drives the disk is proportional to the mass flow rate of the solids, since this motor energy goes to accelerating the material as it passes over the disk. Units can be constructed to handle up to 200 lb per minute with fractional horsepower motors, and can meter most free flowing solids material like dry chemicals, flour, and grain.

9 THERMAL TYPE FLOW METERS

Thermal type flow meters operate on the basic principle that the heat absorbed in a flowing stream when supplied from an outside source is proportional to the rate of flow of the material flowing.

THERMOPILE



The thermopile type is used for measuring gas flows. As used in the low ranges of from 50 to 10,000 cu cm per minute it consists of a flow chamber through which all the flowing material passes. For use in higher ranges it is connected across a calibrated orifice and the differential across the orifice causes a small flow to bypass the orifice and flow through the thermal flow chamber. The thermal flow chamber contains a noble metal thermopile, the hot junctions of which are heated by passing alternating current through them.

The cold junctions are prevented from heating by lowering their resistance and increasing the heat conductivity away from them. The flow of gas through the flow chamber tends to bring the hot and cold junctions to the same temperature, which reduces the voltage output from the thermopile. The voltage output is thus a measure of the velocity of the gas flowing through the unit. The voltage decreases asymptotically to zero as the flow increases. Therefore, a logarithmic scale is produced with each equal division upscale being equivalent to a greater increment of flow increase. This is essentially the reverse of the indication provided by variable head type meters.

Applications

This instrument is suitable for measurement of flow in low ranges of clean gases and a particular use would be for the detection of leakage through valves that are supposed to be closed.

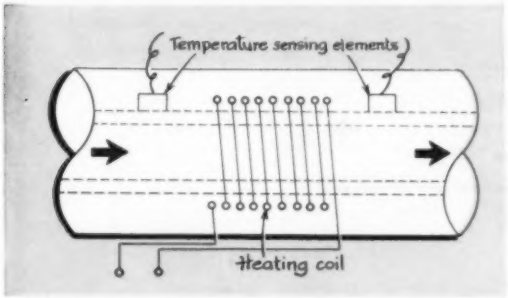
Advantages

1. Measures low flow rates but with a wide range (50 to 10,000 cu cm per minute) when used as a direct flow measuring element because of the logarithmic scale.
2. Can be used as a type of differential transmitter across an orifice plate for higher flow rates.
3. Has a low pressure loss.
4. Can withstand high pressures.
5. Maintains calibration with long extension cables.
6. Has a fast response.
7. Relatively low cost for the flow element.

Disadvantages

The main disadvantages are that it is used only on gases and the rather fragile temperature sensing elements must be protected by means of a fine mesh screen against foreign particles in the flowing stream.

HEATER COIL



The heater coil type of flow element is used for measuring the normal flow rates as would be carried in ⅛ to 8-inch pipes. Special larger and smaller sizes are available. This instrument consists of a flow cell one foot long which is made up of a flow tube (a piece of pipe of line size) through which the fluid flows and which is inserted right in the pipe line. Heater coils are wrapped around the pipe and temperature sensing elements are attached to it which measure the temperature at its surface upstream and downstream of the heater coils. The heater coils and temperature elements are protected from the surrounding atmosphere by a metal shell. Sufficient power is supplied to the heater coil to keep the temperature differential between the upstream and downstream temperature elements constant at approximately 2 F. This temperature differential is a function of the fluid flow rate and the wattage dissipated in the heater coil but is practically independent of the fluid and the ambient temperatures. Therefore, the heater power consumption is practically directly proportional to the fluid flow rate. The flow rate is indicated by a properly calibrated wattmeter and the total flow is indicated by a watt-hour meter which integrates the flow rate.

Applications

This flow element finds its most valuable application in flow measurement where the characteristics of the flowing stream such as high pressure, corrosiveness, toxicity and foreign particle or gas entrainment would interfere with the proper operation of the more conventional type of flow element which is inserted in the flowing stream. It also can be readily used in low static pressure or vacuum flow lines since it causes no pressure drop over that caused by the flow line itself.

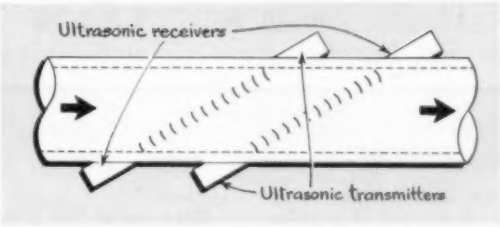
Advantages

1. No obstruction in pipe; therefore no extra pressure drop other than that which would be caused by the pipe itself.
2. Flow element cannot be plugged up, corroded or otherwise damaged by the flowing fluid.
3. Has a linear scale.
4. Pulsating flow does not affect readings.
5. Fast response.
6. Suitable for conductive or non-conductive liquids, slurries and corrosive or toxic fluids.

Disadvantages

The main disadvantage is that it is a rather complex instrument in which two temperatures must be measured, heat must be generated and electrical power must be consumed and controlled and the amount consumed measured. This makes the complete unit fairly expensive.

10 ULTRASONIC WAVE FLOW METERS



The ultrasonic meter is another smooth bore device which, like the magnetic metering element, offers no obstruction to flow. It consists of an insert about two or three pipe diameters long. Two ultrasonic energy transmitters and two transducer receivers enable detecting instruments to measure the difference in transmission times between the upstream and downstream signals. These times are directly proportional to the velocities of the acoustical signals as influenced by that component of measured fluid velocity along the path of the transmitted acoustical signal. If pulsating signals are used at the transmitters, the receiver which senses the wave moving downstream detects a higher frequency while the receiver sensing the upstream wave detects a lower frequency. Each of the two measured frequencies is altered by the flowing stream, and a measure of their difference will directly reflect the volumetric flow rate of the fluid through the device.

Applications

These meters are designed for the measurement of flow in aircraft and missiles; they can handle gasoline, kerosene, liquid oxygen, water, and other low viscosity fluids at rates up to about 4000 gpm.

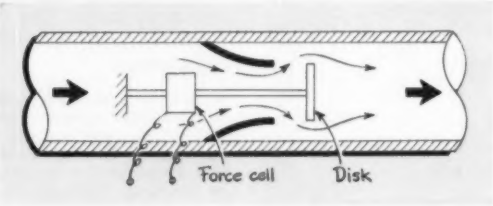
Advantages

1. The device contains no moving parts.
2. Permanent energy loss is very low.
3. Measurement (volumetric) is not affected by density changes in the flowing material.
4. Electrical output signals are easily adaptable to either continuous or digital receiving devices.
5. The element can operate in any position.

Disadvantages

1. High cost prohibits the use of this device on all but special applications.
2. Fluid temperature and outside ambient temperature ranges are seriously limited (about −65 F to 165 F).
3. Mass flow measurement requires a device to measure the acoustic impedance of the fluid (proportional to fluid density) as well as an added circuit to perform the necessary multiplication.
4. High viscosity and other poor ultrasonic property fluids cannot be metered.

11 TARGET METERS



One of the newer types of flow measuring elements is the target meter, consisting of a supported obstruction directly in the flow path.

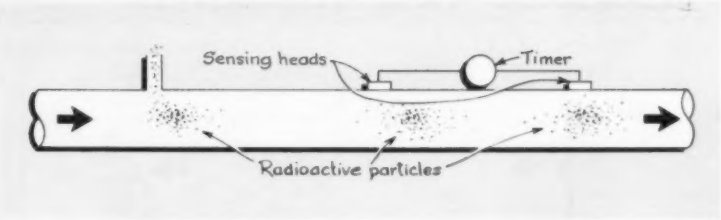
In one version, the instrument consists of a round, flat disk suspended in the center of the pipe in which the fluid is flowing. The disk is attached by means of a stiff rod through a nozzle in the pipe to the diaphragm mechanism of a modified force transmitter. As the flowing fluid impinges upon the flat disk an impact force is produced which, when transmitted through the rod to the transmitter, produces a signal related to flow. In a sense this device is the physical opposite of an orifice installation, the flow path being located in the annular space between the pipe wall and the obstructing disk.

A second version utilizes the same principle as a variable area meter. In this device the obstruction moves within the boundary of a tapered insert, and is effectively a variable area meter on its side. In place of the float weight in a variable area meter, a constant restraining force is provided. The obstruction position is then directly proportional to the rate of flow.

A third target meter senses the rate of fluid flow as a function of the dynamic forces of fluid friction acting upon a streamlined obstruction. This "drag" force is converted to an electrical signal proportional to the flow rate.

These devices are generally compact, easily installed, can handle a variety of materials including slurries and suspensions, and are relatively inexpensive. However, they require measuring systems close-coupled to the flowing line and are thus subject to temperature limitations and physical disturbance from the piping system.

12 RADIOACTIVE TRACER METERING



The newest method of flow measurement is by means of radioactive tracers. A number of installations have been made but this method is still in the development stage and little information is available about it at the present time. However, it promises to be applicable for flow measurements in a rather wide field of hitherto unsolvable flow problems.

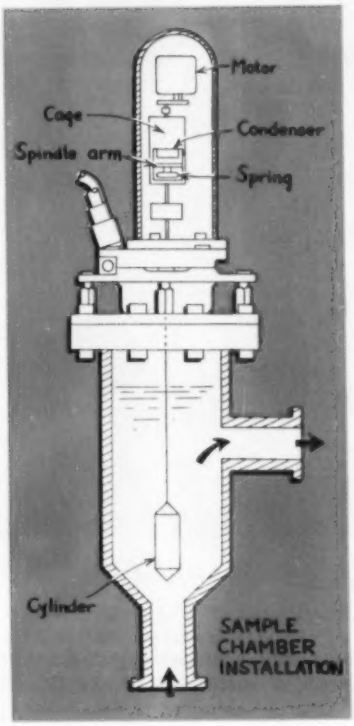
Basically this method consists of injecting small amounts of radioactive materials into the flow stream and measuring the time for them to pass two fixed points, or measuring the strength of the radiation as the material is diffused throughout the flowing stream.

Of course, this method causes no energy loss in the flow system and is mainly useful for measuring very large flows and flows in low pressure or vacuum systems.

Examples of flow problems which have been solved by this method are; (1.) Measurement of sewage flow in large city sewage systems; (2.) measurement of air flow through wind tunnels; (3.) measurement of air flow through large furnaces; (4.) measurement of catalyst flow rates in fluidized catalytic crackers; (5.) measurement of condenser water flow in large powerhouses; and (6.) measurement of flow in drainage ditches and canals.

It is evident that the use of this method of flow measurement is economically advantageous over the use of weirs or other methods of measurement for large flow rates in sewers, drainage or irrigation ditches or canals simply because no large, permanent structure such as a weir has to be installed in each flow site.

Fig. 1—Operation of Viscometran is based upon rotation of cylinder suspended in fluid under test. Drag on cylinder is reflected as an angular displacement between two spring-connected rotating parts. The displacement is proportional to viscosity.



INSTRUMENTATION AND CONTROL

SOLIDS AND LIQUIDS BLENDED FOR

CONTINUOUS CONTROL OF VISCOSITY

An increased number of continuous manufacturing processes involving fluid flow are being designed. It is often found that control of the viscosity of the fluid is too critical to be left to the vacillations of chance. An answer to such a problem is described in this article dealing with a unique instrument-control system.

By R. A. MINARD Brookfield Engineering Laboratories, Inc., Stoughton, Mass.

THERE are many applications for viscosity control in industry. In some cases, viscosity changes indicate the rate or degree of reaction, degree of polymerization, or process end points. In other cases, viscosity will, to a very large degree, determine a liquid's ability to spread, coat, flow, or to be applied. Viscosity control might be attempted by controlling such secondary parameters as density or solids-liquids ratio. In the interest of uniformity, however, direct control of the variable itself is required since slight variations in incoming materials, both solids and liquids, will affect viscosity. The need for direct viscosity control of solvent-base fluids is particularly critical. Regardless of the uniformity to which such a fluid has been initially prepared, due to evaporation or preferential absorption, viscosity will change while the fluid is being used. The rate of change is not slow: extremes of 30 per cent change per minute have been noted, though 2 to 5 per cent per minute is found most frequently. In short, a strong case can be made for control of viscosity based upon direct measurements of viscosity while a given fluid is being used.

For continuous indication, recording and control of viscosity under process conditions, Brookfield Engineering Laboratories Inc. manufactures the Viscometran. The operation of the instrument

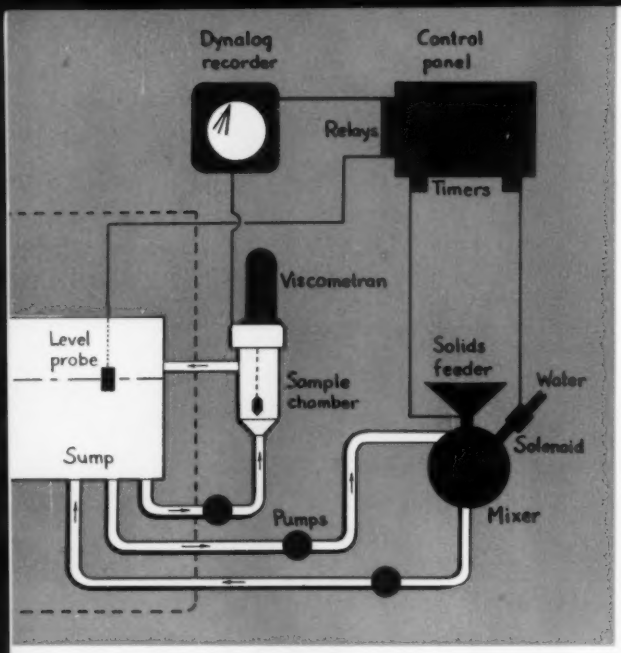


Fig. 2—Schematic diagram of system which provides for continuous control of viscosity in a food processing operation. Solids and water are introduced into system as needed to keep sump filled to desired level and to keep viscosity within desired limits.

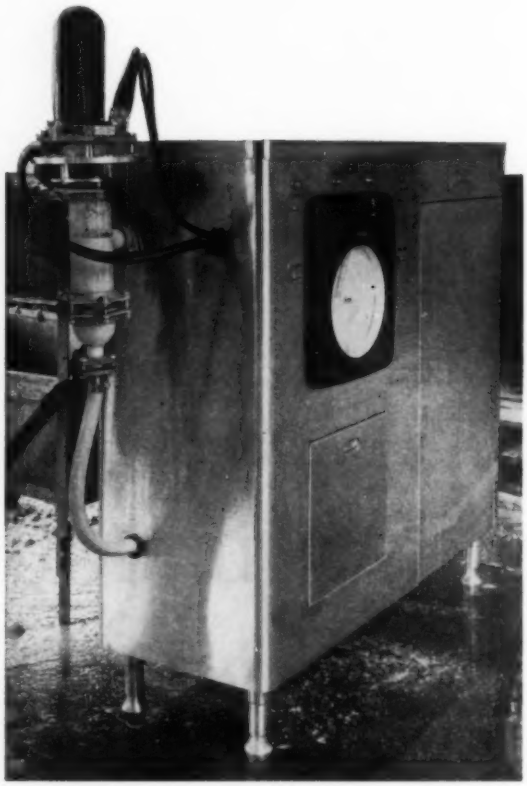


Fig. 3—Brookfield Viscometran is on side of sump housing; liquid is continuously circulated through sample chamber mounted below the instrument.

is based upon the constant speed rotation of a cylinder which is suspended in the liquid under test, *Fig.* 1. Torque required to rotate the cylinder is directly proportional to the centipoise viscosity of the fluid. In operation, a synchronous motor drives a cage coupled through a beryllium copper spring to a spindle arm which supports the spindle or cylinder in the fluid being measured. During measurement, the spring tends to wind up until its force exactly equals the viscous drag on the cylinder. At this point, the cage and cylinder both rotate at the same speed but with a definite angular relationship to each other proportional to the torque on the spring.

Two methods are used to transform the angular relationship into a viscosity reading: variable capacitance or variable resistance. In the first case, one side of a variable condenser is attached to the cage and the other to the spindle arm. The angular relationship between the cage and the spindle is thus made proportional to a capacitance. This variable condenser type is preferable for most applications in low viscosity ranges. The second method of signaling is based upon a potentiometer mounted in the cage with its free member connected to the spindle arm. Angular relationship between the cage and spindle is made proportional to the resistance. In either case, the Viscometran transmits a viscosity signal to a suitable receiver by sending an electrical impluse which is proportional to the torque required to rotate the spindle.

Coating or dipping processes furnish excellent illustrations of the instrument's application since optimum performance is dependent upon sensing and control of viscosity during use. Examples can be cited in the sizing and bonding of nylon threads, aniline and gravure printing, manufacturing printed circuits, coating of paper, or applying adhesives.

In some food preparation processes, control of viscosity is also critical, involving the control of the mixing of a fluid to a desired viscous range and maintaining the quantity of viscous fluid at a desired level in a tank. For example, the Wilevco system, manufactured by W. L. Cummings & Co., is an integrated, completely controlled system presently used in the manufacture of frozen fish sticks and other breaded products where a batter-mix is involved, *Fig.* 2.

In this particular breading operation, sections of frozen fish pass through the curtain of an enrober where they are covered with a stream of batter. Immediately after this, they pass beneath a curtain of bread crumbs which adhere to the product as a result of the stickiness of the batter. The fish are then fried, cooled and packaged.

Application of batter is critical to the manufacture of the product: The operation determines the final size of individual sticks and, to a degree, the ability of the product to fit into the package; the net weight of the product is affected; and the

evenness of coating and product color, important to customer satisfaction, are determined by the uniformity of batter application. Thus the effectiveness of processing and the quality of the resulting product are in direct proportion to the degree to which the viscosity of the batter can be controlled.

The Wilevco system is made up of several pieces of equipment including a Fitzpatrick Homoloid, a Brookfield Viscometran, a Foxboro Dynalog recorder, Electronic Corp. of America photoswitch level probe, and a control panel.

Batter-mix viscosity is controlled by admitting solid ingredients and/or liquids into the Homoloid mixer according to the desired viscosity and volume requirements of the system. The Homoloid acts continuously, but the feeders admit new materials to the process only when actuated by the interlocked control elements—the viscosity meter and the level probe.

The batter is continuously circulated from the mixer to the sump in the enrober and back to the mixer. A separate circulating line from the sump is provided to circulate the batter through a sample chamber where viscosity is sensed, *Fig.* 3. The Viscometran is coupled to a Foxboro Dynalog recorder which records the viscosity and, through its controls, actuates relays if the viscosity varies high or low from an "on-control" zone. The on-control zone is adjustable from the face of the recorder by changing the space between the high and low indices, *Fig.* 4.

If the level probe mounted in the sump signals that the level is down, the system will add both solids and liquids only if the viscosity is within the on-control zone. Materials are added continuously until the level is brought up or the viscosity wanders from the control zone. Viscosity adjustments are made by adding solids if the viscosity is low, or liquids if viscosity is high. A form of proportional control is used here in the sense that the power to the solenoid valve controlling liquid input and the vibratory feeder controlling solids input is made intermittent by being periodically switched *On* and *Off* by timers, *Fig.*5. This results in extremely close control and eliminates any overshoot. Due to the constant drain on the supply and the constant variation of the viscosity, the system is never truly stable. In practice it will cycle continuously from level adjustment to viscosity adjustment—the net effect is that the control viscosity zone can be made quite small and the viscosity cycle will remain within this setting while the level is also continuously adjusted to the desired amount. Manual override switches are provided so that the operator can add solids, liquids, or both, regardless of the level and/or viscosity. This permits rapid make-up of the initial batch.

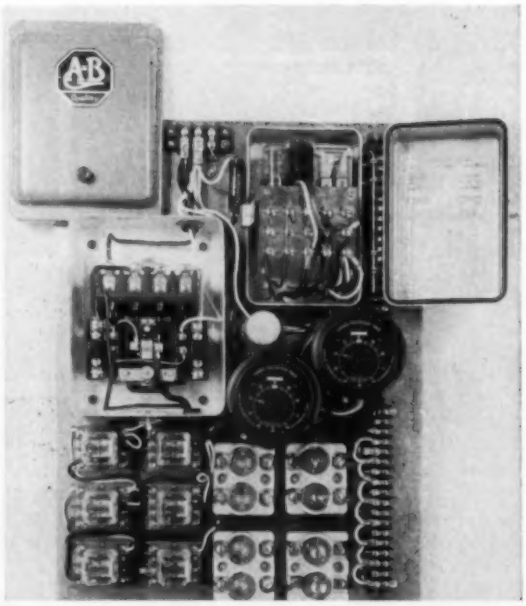


Fig. 5—Control panel of Wilevco system. Percentage timers provide for intermittent action in feeding materials into system to prevent overshoot when adjusting viscosity.

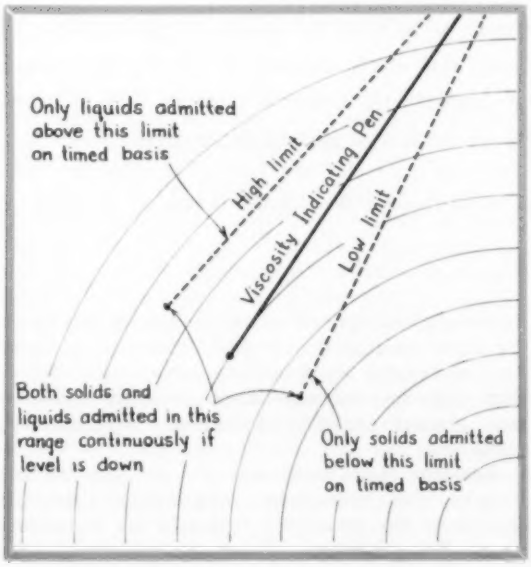

Only liquids admitted above this limit on timed basis
High limit
Viscosity Indicating Pen
Low limit
Both solids and liquids admitted in this range continuously if level is down
Only solids admitted below this limit on timed basis

Fig. 4—Schematic of face of Foxboro Dynalog recorder shows relationship of control action for introduction of water and solids in either adjusting viscosity and/or level of fluid.

While the primary use of the system which has been described has been in the manufacture of fish sticks, the apparatus has potential applications outside the food field. The manufacture of glue, or the preparation and control of resin-solvent slurries in the coating of electronic components can be improved through the use of this type of system. Its advantages cannot be ignored. Where needed, continuous viscosity control results in production economies through the reduction of off-quality product, the maintaining of closer manufacturing tolerances, and savings in raw materials and labor.

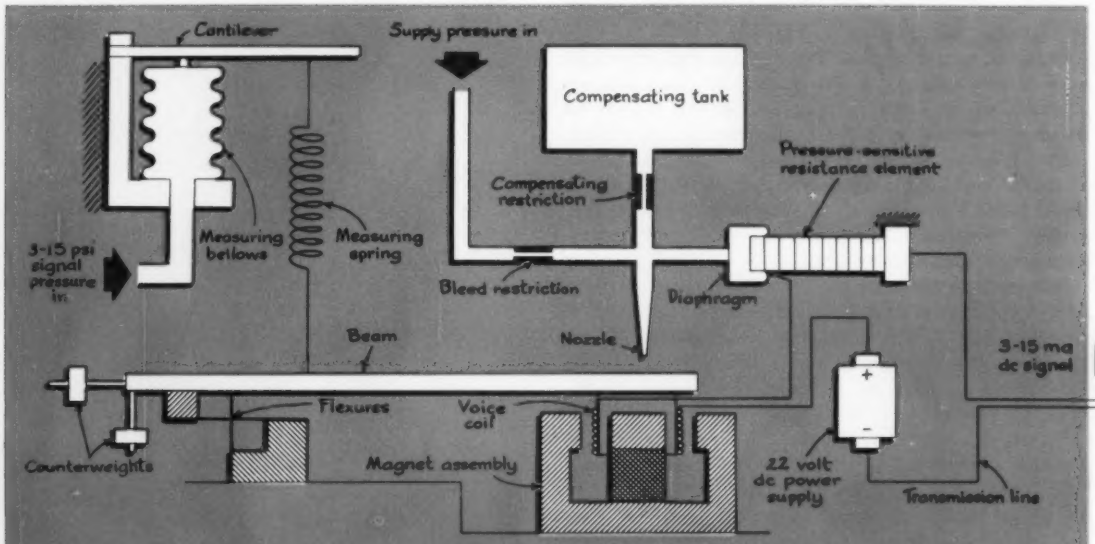


Fig. 1—Details of pneumatic-electric transducer which changes 3 to 15 psi air input signals into 3 to 15 ma dc signals for transmission by wires. Transmission line lengths up to 5 miles may be used.

INSTRUMENTATION AND CONTROL

ACCURATE TRANSMISSION OF SIGNALS WITH

The relative advantages of electrical and pneumatic control systems have been and remain a subject of much debate. Some of the arguments pro and con for each system are here discussed, and a pneumatic-electric-pneumatic control system which combines some of the merits of both systems is described.

By **RALPH V. COLES**, Assistant Vice President, Fielden Instrument Division, Robertshaw-Fulton Controls Co., Philadelphia, Pa.

DURING THE past several years there have been many papers written and many panel discussions held on the relative merits and demerits of electrical and pneumatic control systems. Some of the arguments put forward are valid and accepted as factual by almost everyone; others are tenuous and more matters of opinion than of fact. Unfortunately, some of the latter are advanced so convincingly as to becloud the issues and therefore prevent one from securing a true perspective of the controversy. Examples of two such arguments, one from each side, will be discussed.

First, it can be demonstrated that some electrical devices or circuits can, under certain conditions, ignite some dangerous mixtures of gases and thereby cause an explosion or fire. This is a perfectly true statement which no one can dispute. Therefore, say the pneumatics men, all electrical devices and circuits are suspect and we must not use them.

Actually, these same men probably use thermocoup'es for measuring temperatures and pH equipment for measuring hydrogen ion concentrations. But they have struck their blow, and in the minds of those who have no real understanding of the meaning of intrinsic safety a seed of doubt has been sown. As a result, those blindly following the old adage, "Better be safe than sorry,"

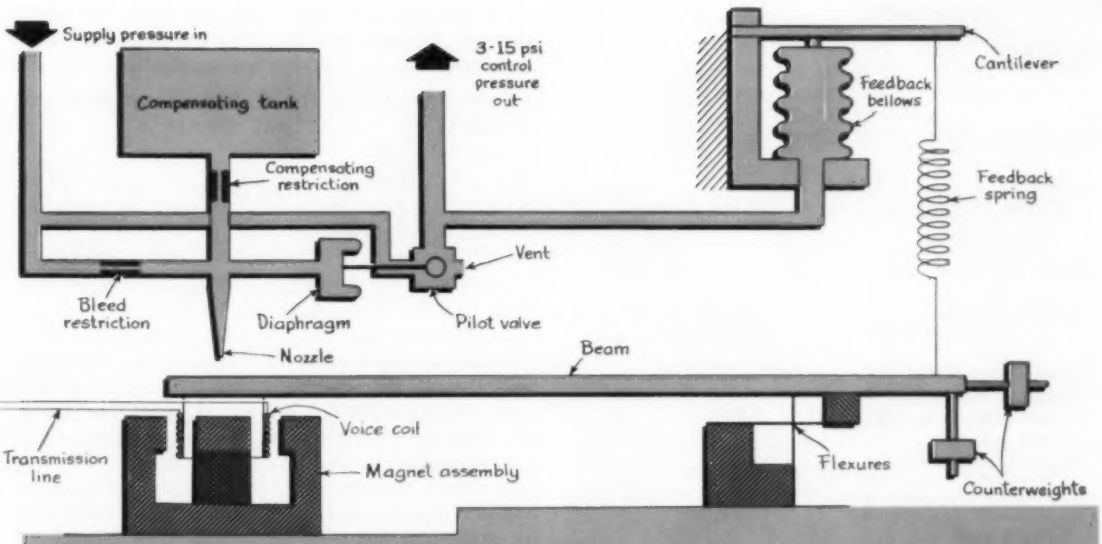


Fig. 2—Diagram of electric-pneumatic converter. Incoming electrical signals from the transmission line are converted into a duplicate of the original pneumatic signal. This is then fed to instruments or control devices.

ELECTROPNEUMATIC CONTROL

may well specify equipment that has poorer performance, is less suitable, and has larger installed cost than need be.

On the other hand, the problem of maintenance of electrical, and in particular electronic, systems is a very real one. Statements are made that "any television technician can maintain an electronic system." But first you have to have the television technician, and they are not as common as the statement seems to imply. Getting down to bedrock, a pneumatic system is a mechanical system that is relatively easy to understand, to take apart and to reassemble. Any high school graduate or a man with a limited technical education has a good chance of understanding and maintaining a pneumatic system. An electronic system on the other hand is a concatenation of a number of small components that are immobile, the workings of which can only be understood by those who have had specialized training or education.

To those who may be disposed to counter this argument with the idea of plug-in assemblies, which are discarded in the event of failure, it should be recognized that discarding is a relatively expensive maintenance procedure. And since plugs and sockets do not make solid connections, but rely on spring pressure, they are subject to high resistance contact under certain conditions. In applications where this is a factor, they should only be used when the anticipated life of the component or subassembly is less than the period of time over which the plug and socket can be expected to maintain a low-resistance contact.

The established factual arguments in favor of each system are itemized in TABLE 1. Electrical or electronic systems can be made to have greater sensitivity. Certain variables can only be measured electrically. They have, relatively, no transmission lag and transmission can be more flexible and can be carried out over greater distances at lower cost. Maintenance of the transmission link is simple and relatively low in cost. Pneumatic systems on the other hand have superior power handling capacity. Their maintenance is relatively simple and economical and at the present time final control elements are predominantly pneumatically operated. In other words, each system has certain merits.

The question may now be asked, "Can the better features peculiar to each be combined in a hybrid system which will out-perform either system

TABLE 1
Merits of Electrical and Pneumatic Systems

Electrical	Pneumatic
1. Greater sensitivity	1. Greater power handling capacity
2. Means available for measuring all known variables	2. Maintenance is simpler and more economical
3. No transmission lag	3. Requires no conversion at the final control element
4. Greater flexibility and distance of transmission	
5. Transmission lines over a certain minimum length have lower installation and maintenance costs	

alone?" The answer is probably "yes." Even if it is agreed that ultimately the all electric or electronic system will prevail, it is going to be a very gradual, long-term process because of the heavy investment in pneumatic systems, components and training that already exists. Possibly by taking intermediate steps the transition to, acceptance of and training in electronic techniques can be made easier. With this philosophy in mind, Robertshaw-Fulton Controls Co. has developed an interesting system which illustrates the idea.

A pneumatic pressure to direct current transducer, *Fig.* 1, translates 3 to 15 psi signals from the controlled process or machine into electrical signals of 3 to 15 ma dc. This current is conducted by small transmission wires to a remotely located direct current to pneumatic pressure converter, *Fig.* 2. The output of the converter, a pneumatic signal of 3 to 15 psi, may be used to operate valves or other pneumatic control elements.

Advantages obtained from this hybrid setup include: (1) Vacuum tubes and critical electronic circuitry are avoided as a source of maintenance expense. This also permits flexibility of placement of the control equipment to suit external needs, without special regard to accessibility; (2) the low electrical energy level at which the system operates provides ample protection against explosions in hazardous atmospheres; and (3) standard indicating or recording milliammeters may be connected at any place in the line without affecting calibration.

Of interest at this point are the criteria by which the 3 to 15 ma level for the dc transmission line signal was established in lieu of using the more common 1-5 ma found in other systems. The main reasons are:

1. Numerical identity with existing pneumatic standards of 3 to 15 psi, offering a 1:1 signal conversion ratio.

2. A 1:5 ratio of minimum to maximum current is the range most frequently stated to be preferred by controller manufacturers in a recent SAMA poll. This coincides with the 1:5 range of minimum to maximum air pressures used in pneumatic systems—a universally accepted standard.

3. Maximum current should be compatible with the capabilities of common industrial vacuum tubes and transistors operating conservatively within their ratings in similar service. In short, the means of signal generation should have a power handling capacity capable of providing at least a 100 per cent safety margin. The 6SN7GT and its high reliability equivalent type 5692, or the 12AU7 and its equivalent the 5963 or 5814A were considered ideal industrial vacuum tubes. The maximum signal capacity of these tubes connected in parallel. 40 ma, was felt to offer a good guide to the maximum signal level of the systems. This indicated that the maximum transmission signal level should not exceed 20 ma.

Operating characteristics of power transistors are not as well established, but a maximum current of 50 ma or a maximum safe signal of 25 ma for a single power transistor appears to be a good compromise at the present time.

4. System should have relative immunity against errors due to changes in transmission line leakage and for different line lengths. By varying the max-

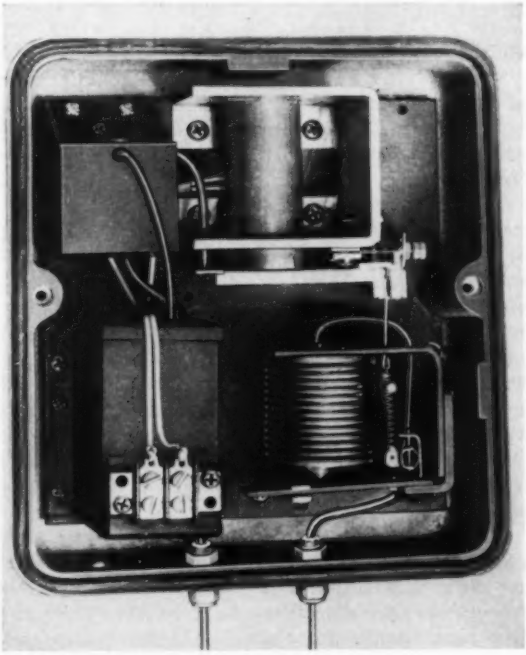


Fig. 3—An actual pneumatic-electric transducer. Magnet assembly cover has been removed to expose the nozzle and the flexure-mounted beam.

imum current range and studying the effect on such factors as the error due to changes in transmission line leakage and the necessary power supply voltage, it can be shown that 2-10 ma or higher is the best range. A similar investigation of the effect on accuracy of changes in the series or loop resistance of a transmission line as the maximum current range is varied shows that a range of 4-20 ma or lower is best. Since 20 ma has been chosen as a maximum, the range of 3-15 ma is an ideal compromise.

The error in the absolute value of received current due to a given line leakage is a function of the converter voice coil resistance or input resistance. For a given line length, the error is almost directly proportional to this resistance. Assuming the same force change representing full scale for both 1 to 5 and 3 to 15 ma current levels, this error becomes only 1/9 that of a 1 to 5 ma device in an instrument operating at the 3 to 15 ma level. This results because 1/3 the number of turns are needed to maintain the same force change for the higher operating level. At the same time, a larger wire size can be used to fill up the available space. The combination of fewer turns and use of larger wire size results in the coil resistance, and consequently the error in absolute value of received signal, being reduced by a factor of nine.

TABLE 2—Performance Characteristics for Pneumatic-Electric-Pneumatic System

Parameter	Operating Conditions	Effect of Variation of External Parameters On Output Reading	
		Transducer	Converter
Power supply input volts	117 plus or minus 10 per cent, 50-60 cps	0.005 per cent of reading, per volt	
Supply air pressure	18-20 psi	0.03 per cent of full scale, per psi	0.03 per cent of full scale, per psi
Transmission line resistance	100-1000 ohms	0.02 per cent of reading, per 100 ohm change of line resistance	

▶ Operation

Force applied to the flexure-pivoted beam of the transducer, *Fig.* 1, via the measuring spring affects the separation between the beam and the nozzle. This results in a change in the nozzle back pressure which, when applied to the pressure-sensitive resistance element through the diaphragm, causes a corresponding change in resistance. The resistance change in turn affects the transmission line current by the amount needed to rebalance the transducer beam via its voice coil. Thus, a dc current output is obtained which is directly proportional to the measured variable applying the input force to the beam. By use of the pneumatic flapper-nozzle mechanism, large power amplification is obtained without recourse to electronic circuits. The effects of supply pressure variations, power supply voltage fluctuations and the characteristics of the resistance element can be made negligible by suitable sensitivity of this mechanism to changes in the nozzle back pressure.

The dc transmission line is inherently unaffected by 60-cycle ac pickup, and simple D'Arsonval movement meters may be connected at any point to indicate its operation. Placement of the dc power supply is also flexible, and conventional units or batteries may be used. One supply can power several systems.

The converter, *Fig.* 2, is of conventional design and several equivalent versions are commercially available. Changes in the received electric current act on the voice coil to change the separation between the beam and the nozzle. The corresponding change in nozzle back pressure is used to rebalance the beam via the feedback bellows and spring. At the same time, an output pressure is developed to operate control valves or other control elements. Supply air is merely a source of power and not a calibrated function of the system.

An actual transducer is shown in *Fig.* 3, and a converter in *Fig.* 4. In general, the same basic components are used in each. For the converter, however, the pressure-sensitive resistance element in the transducer is replaced by the pneumatic pilot valve, and the feedback bellows substitutes for the measuring bellows. A heavy cantilever spring used to restrain the motion of the bellows is made of Ni-Span-C alloy to reduce the effects of variations of ambient temperature on the accuracy. Temperature effects on the flux density in the magnet and the linear thermal expansion of the transducer chassis can be almost exactly compensated for by proper choice of the material for the measuring and feedback springs. TABLE 2 shows performance characteristics for both units. These specifications show that the system is suitable for measuring and transmitting absolute values of variables as well as for transmitting the output pressure of a pneumatic controller to a control valve. The accuracy requirements are of

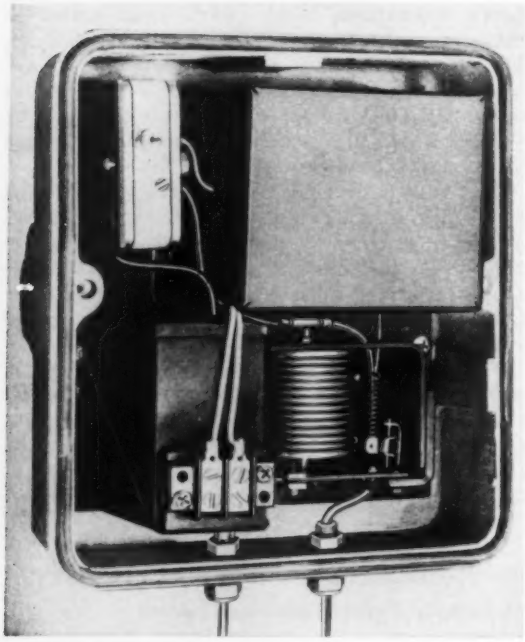


Fig. 4—This electric-pneumatic converter works in conjunction with the transducer of Fig. 3.

course much less stringent in the latter case, since the controller supplies corrective action for any disturbing factors introduced.

Thus a complete measuring, recording, transmitting and controlling system has been evolved which uses no vacuum tubes or complex electronic circuits. In addition, it combines the best features of pneumatic and electrical operation. Because of its action, the hybrid system is designated P-E-P (pneumatic-electric-pneumatic).

▶ Future Developments

It is clear that the input motion may be derived from various elements such as Bourdon tubes, bellows, filled systems and mechanical pickups, so that the system can be applied to direct process variable transmission and to valve positioners as well as the transmission of control signals. The future will see a whole family of primary elements designed around the basic transducer. Under development also is a controller which contains an appropriate feedback network to produce proportional, reset and rate actions. These actions will be transmitted electrically to the converter for actuating a control valve or other pneumatic control elements.

HYDRAULICALLY OPERATED VALVES CONTROL PROCESS

IN PREPARING PLANS for a new, fully automatic butadiene processing plant, the Texas Butadiene & Chemicals Corp. desired greater flexibility of control over the flow of butadiene ingredients into reactors, as well as faster operation and lower cost output than heretofore known to the industry. Processing of butadiene, used in synthetic rubber and some plastics, requires precise control over ingredient flow volume and velocity, as well as over the sequencing of ingredients into reactors.

To meet operating requirements an all-hydraulic system of control was adopted to operate product valves. The system was designed and built by Rivett Inc.

Hydraulics provided precise and flexible control over product flow, plus simplified operation, a central power supply, lower initial cost and lower operating cost. Only one source of power is required—at the central power unit—reducing the actual connected horsepower from an estimated 400-500 hp that would have been needed if electric motors were used to control the new plant, to 30 hp required by the hydraulic system.

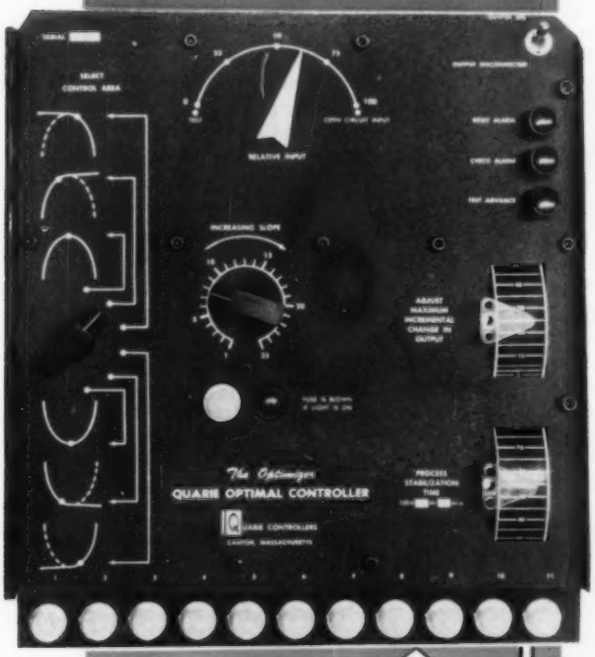
Product gate valves are operated by small, light hydraulic cylinders, which in turn are operated by solenoid valves located at the central control panels. Gate valve sizes handled by the new system range in size from 4 to 30 inches. Operating times for the gate valves are as low as 1 sec for smaller valves and 4 sec for larger sizes.

A number of independently operating control units are used; each unit controls the necessary gate valves for seven reactor vessels, each of which has seven gate valves. To simplify operation and keep piping and electrical wiring to a minimum, Rivett engineers designed common steel mounting panels, with drilled interconnections, for each gate valve circuit. All valves and filters for operating each gate valve are mounted on these panels. The panels for each reactor were then grouped and contained in a cabinet.

High pressure oil from the power unit enters the panels and flows through full-flow, 40 micron, 2000 psi filters to 4-way valves, which, in turn, control the flow of oil to the gate valve actuating cylinders.

Advantages of the selection of hydraulic control for Texas Butadiene & Chemical Corp. were many. Control wiring and size of installation were reduced to approximately one-tenth of that required by a similar electrical control system. Rate of gate valve travel can easily be varied at any point in the stroke, and slow starts or stops can be gained by simple external valving.

Fig. 1—Control panel of Quarie optimal controller. In putting the controller on-stream, the Select Control Area switch is set to position conforming to curve form and slope direction indicated by a study of process variables. Other settings possible on control panel include: adjustment of maximum incremental change in output; adjustment of process stabilization time; adjustment for actual slope value; and adjustment for input span and zero suppression.



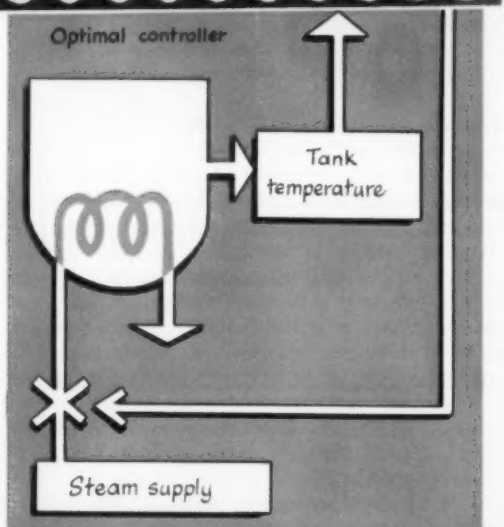


Fig. 2—Simplified problem to which optimal control can be applied. It is desired that steam supply be varied to obtain hottest temperature in tank with most economical use of steam.

INSTRUMENTATION AND CONTROL

ANALOG COMPUTING DEVICE PROVIDES OPTIMAL CONTROL

Described in this article is a different concept of controller design. The actions of the device result in a much sought-after goal in process industries —obtaining an optimum result in terms of cost, yield or any desired parameter.

OPTIMAL control implies the control of a system such that the most favorable result becomes a reality. Typically, it is obtained as a compromise among the possible effects which result from manipulating the variables of a system. Process industries, in particular, have many operations where optimal control is sought: maximizing product output from a catalyst reaction; minimizing cost by controlling steam usage in process heaters; and maximizing boiler temperature by controlling fuel—air ratios are typical examples. In short, a process is a likely candidate for optimal control if the value of one variable can be stated as a function of a controlled variable.

Typically, the relationship of two operating variables of a system can be shown by plotting a curve, assuming that other system variables or base conditions are constant. Changes in base conditions for a given situation result in a change in the curve which describes the relationship of the two operating variables; thus, a typical process control problem is properly represented by a family

of curves since system variables are subject to change.

Optimal control of a process represented by a curve can be described mathematically as the slope of the curve at some point if proper variables are chosen. An example would be pounds of steam per pound of fuel—a ratio which could describe an optimum condition. The special case would be zero slope which would represent the most or least of some particular parameter—a maximizing or minimizing of one variable as a function of the value of another. However, a point of zero slope is not always the desired control point. There are a large group of functions whose characteristics are essentially logarithmic or square-law in nature. In such cases, optimal control, in terms of dollars or output, would be achieved at some point around the knee of a curve showing the relationship of the operating variables.

A controller whose action is based upon the slope of a curve or ratio of two variables can provide a completely non-linear control system. There need not be a fixed relationship between the input and output signals, either in magnitude or sense of direction. Such a controller would change one variable in order to hold control over another but instead of the control action holding a fixed condition, the controller would maintain operations at the point of tangency between a line representing the desired slope and the process curve itself. And when a process is described by a family of curves, the controller would follow changes and maintain operations as a desired slope in spite of factors which would tend to displace the process curve.

Available Controller

Such a controller whose action is based upon the slope of curves is manufactured by Quarie Controllers, *Fig.* 1. The operation of a Quarie optimal controller can be best described by reference to an application. For instance, a process might require that a process tank is to be heated from a steam line in which supply temperature varies, *Fig.* 2. It is desired to get the tank as hot as is practical without wasting steam. The assumed operating relationship of tank temperature versus steam flow is shown in *Fig.* 3. The family of curves represents conditions for variations in steam temperature.

The optimal controller can be set to control the process at operating conditions defined by the slope of the curve at a point that would represent the economic balance between cost of steam and value of heat available in the process plant. The

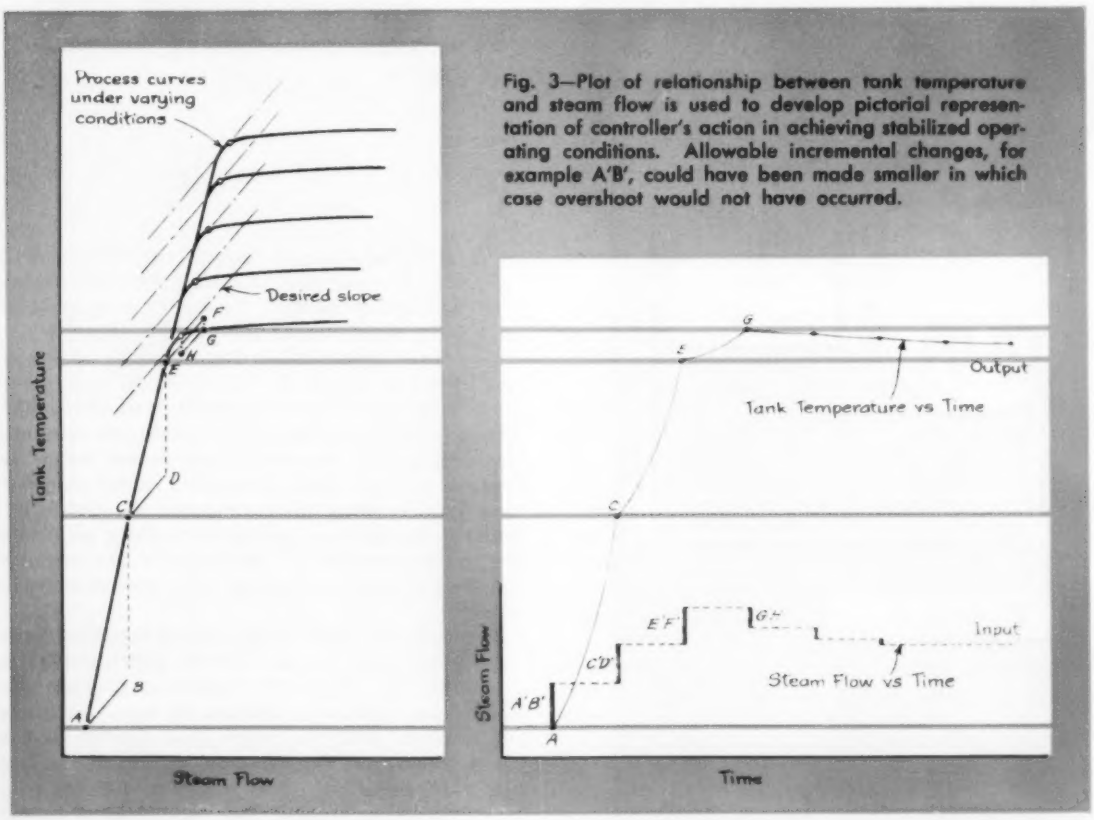


Fig. 3—Plot of relationship between tank temperature and steam flow is used to develop pictorial representation of controller's action in achieving stabilized operating conditions. Allowable incremental changes, for example A'B', could have been made smaller in which case overshoot would not have occurred.

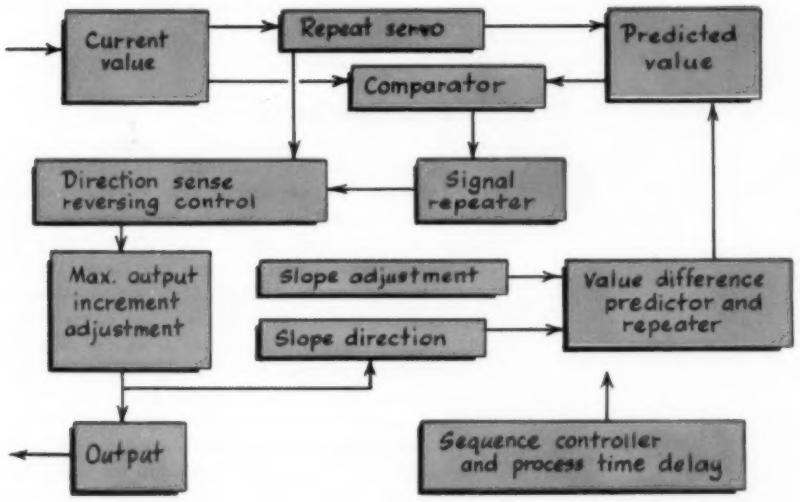


Fig. 4—Block diagram of optimal controller's action. Input is an analog shaft rotation; output is to electric circuit which drives an instrument motor.

controller would sense temperature in the tank but control steam flow independent of steam temperature.

The controller is essentially a computing device which performs logical operations. In addition to the desired slope, two major factors enter into calculations performed by the controller: one is concerned with time—a damping factor and the time-delay of a system in reacting to a change in the controlled variable; the other factor is concerned with the allowable maximum incremental change which can be made in the controlled variable. Taking the information as to the amount of incremental change of the system input (steam flow), the desired control slope, and the current system output (tank temperature), the controller predicts what the new value of the system output should be after it has stabilized from a change. The control action is based on the difference and direction between actual and predicted values.

Thus, as is shown in *Fig.* 3, the controller is put on stream at point *A*. The desired control slope, which is set on the controller, is represented by the slope of *AB*. The abscissa of *AB* represents the maximum allowable incremental change in the system input; this is plotted as *A'B'* on curve of steam flow versus time. After a time delay, the controller determines that the change in steam flow has resulted in a new tank temperature *C* rather than the predicted temperature *B* which would have been observed if actual conditions fulfilled control expectations. The controller then makes another incremental change in steam flow *C'D'* and predicts a temperature *D*. Upon sensing that the temperature is actually *E* after the time delay, still another change is made with a new predicted temperature *F*. As shown, the temperature becomes *G*—a situation in which the current value is less than the predicted value. The controller reverses its action, changing the system input in attempting to reach a new predicted value *H*. The incremental changes are decreased as the difference between current and predicted values becomes smaller and in further control action the system converges to the desired slope control point until the current value is the same as the predicted value at which time the system stabilizes.

▶ Operational Details

A block diagram of the controller's action is shown in *Fig.* 4. The operational sequence is as follows:

1. Compare the current and predicted values and, if indicated, store a reversing signal at the bistable signal repeater.

2. Change the predicted value storage to equal the current value as a starting place for a new predicted value. At the same time provide an output and compute and store a predicted difference value which is the product of the output change, the desired rate-of-slope and the slope direction. The output and the predicted difference value may be limited in amount by the maximum output increment adjustment.

3. Add the predicted difference value to the current value at the predicted value storage to obtain a new predicted value.

4. If a signal was stored at the signal repeater in the first step, use that signal to reverse the direction of the output.

5. Recycle after the process time delay.

The variation in incremental changes results from a time-base established by the action of the repeat servo in the system in changing the predicted value storage to equal the current value. The time-base of the output from the controller is adjustable up to ten seconds maximum. This represents approximately 35 per cent of the total possible drive time of the repeat servo between the predicted and the current values. Therefore it is probable that the normal maximum settings for the controller will be between two and four

seconds. The output is a three-wire circuit for driving a two-phase, 115v, 60 cycle instrument motor of any rating up to 100w. As such, the output changes the setting, for example, of an air pressure valve by a discrete amount. It should be noted that the output is not a signal proportional to the change in the sensed variable; it is a differential increment proportional to the difference between the sensed variable and a varying ideal value of the sensed variable.

The input to the controller is an analog shaft rotation. As most sensing elements have a voltage output, the controller is normally equipped with an input servo. Since the operation of the controller depends only upon differences derived from successive values of the output of the system, there is no need for calibration of the controller input, nor does the input signal need to be linear with respect to the input variable. Further, the input servo needs only sufficient stability to maintain repeatability within the desired accuracy over the process delay time. It is not necessary to match the span of the controller to the input function, but rather it is required only to have the controller span cover the range of the input function taking into account the family of curves and the limits of change in value due to momentary process upsets. Thus by suppressing the zero and expanding the scale to cover only the required range, the accuracy of the controller in holding the desired control region may be increased two to five times over the scale accuracy of the internal repeat servos. As a result it is possible to accomplish good optimal control with comparatively coarse equipment, and compromises may be made in favor of long life and high reliability of the equipment.

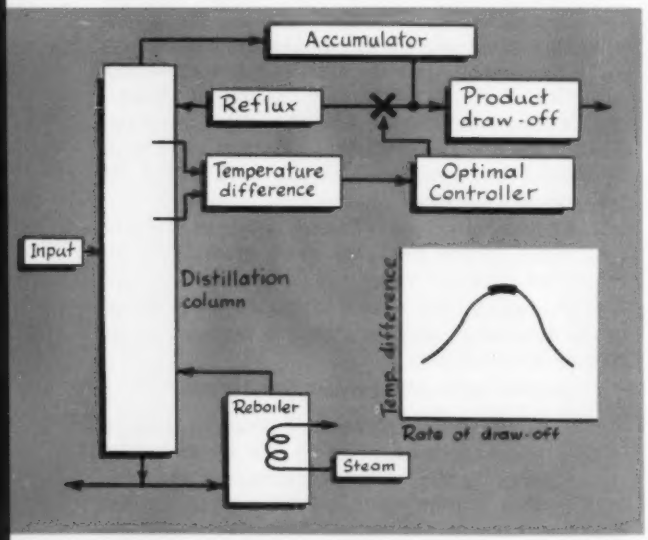


Fig. 5—Simple binary distillation column is controlled to hold process to indicated maximum point of the curve. Lower temperature sensor gives maximum sensitivity to process upsets due either to input conditions or heat change in the reboiler. Upper sensor gives maximum sensitivity to changes in product.

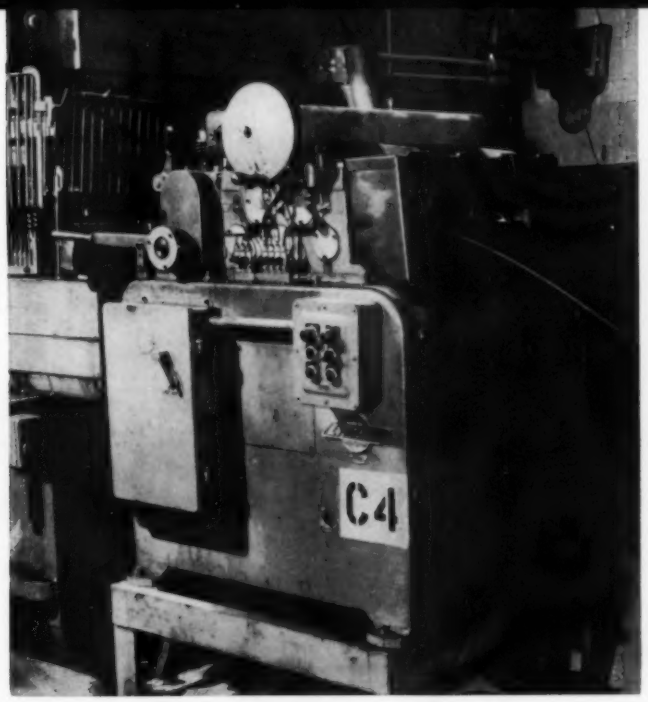
A Flexible Device

Application of the controller to problems of single variable input and single variable output is straightforward. It might be required, however, to use the controller in multiple variable systems which require two or more inputs to the controller, two or more outputs, or combinations of multiple inputs and outputs. In these cases it may be possible to use ratios or sums as the input to the controller without loss of stability, *Fig.* 5.

Other solutions to the multiple variable systems are possible. For instance when two or more completely independent inputs to the controller must be handled, either parallel operation or time sharing may be used. For parallel operation any reasonable number of the controllers may be operated either from a common input or to a common output. Generally, the controller associated with the most active variable is set to the stabilization time of the process. The next most active variable is changed once for every two or three times the first one is changed, etc. For time sharing operation, it is possible to switch the controller functions from one variable to another as a substitute for parallel operation. The output of the controller can be switched directly from one variable to the next but switching of the controller input is not recommended as it is not practical to build the necessary repeat and memory circuits to hold the predicted values necessary if stability is to be achieved.

Being inherently an intermittent device in that it allows time for stabilizing of the process after each incremental change in the operating conditions, the Quarie controller can be used with sampling-type measurement equipment as well as continuous transducers. With sampling devices, the controller triggers the sampling equipment or has its cycle started by the instrument.

It can be seen that the controller is flexible in nature. There is no fixed relationship between the output and input signals. The controller constantly searches the operating region for and holds the conditions which fit the instructions given it. In general, the change in process efficiency due to optimal control will be small simply because present control techniques are good and the engineering data on which the set points are based has been well evaluated and the proper compromises made. However, day to day variations in the "on-stream" conditions give rise to deviations from the ideal which cannot possibly be evaluated and taken into account. Conditions may change while taking the data to evaluate an apparent upset. The controller follows these changing conditions as they occur and continuously seeks and holds the best compromise in "on-stream" conditions. Even though percentage gains may be small, the true worth of the controller is measured by these gains in terms of through-put.



1 This is the beginning of AC Spark Plug's integrated production line that makes shells for full-flow oil filters for Chevrolet V-8 engines. Preparatory to formation of shell blanks, coil stock is fed through this Littell hydraulic straightener.

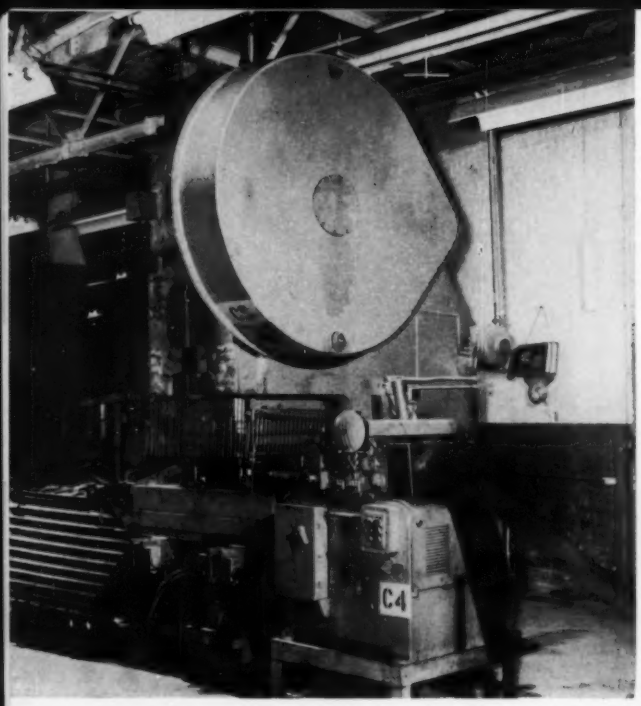
AUTOMATION TODAY

PRODUCING OIL FILTER SHELLS

ON STANDARD PRODUCTION EQUIPMENT

AN INTEGRATED production line has been developed by AC Spark Plug Div. of General Motors Corp. for shell production for its full-flow oil filter used with the Chevrolet V-8 engine. This has been accomplished without employing special production equipment or a new facility. The layout is an example of what can be done with standard equipment and existing facilities to gain the benefits of an integrated flow of production.

An outstanding feature of the line is a storage conveyor system occupying normally unused space overhead. This is a flat chain system with each length of chain having an individual motor drive unit. Chain wear and the possibility of the workpieces becoming scuffed are reduced since the motor shuts off automatically when a section of chain becomes loaded to full storage capacity. As parts are discharged from



2

Here, together with the hydraulic straightener, is the Verson blanking press into which the stock is fed. Stock is blanked through the die to an inclined chute. It travels by gravity to an inclined magnetic elevator, then is deposited automatically in a wicker-type conveyor on other side of press.

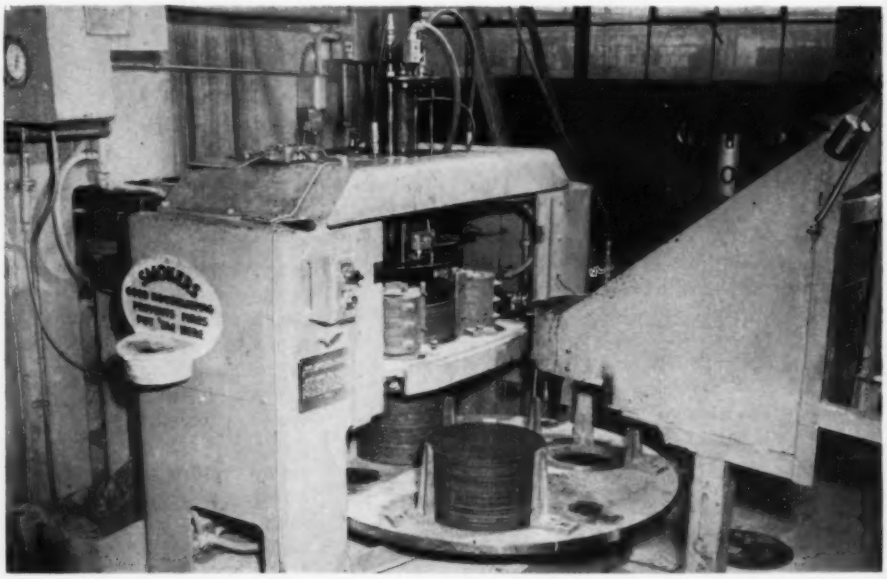
the system, each drive unit will in turn start up to move all of the stored parts toward the exit end. Another design advantage is that the system's capacity can be doubled by suspending another bank from the originally installed unit and still allow sufficient overhead clearance for operations below.

Another feature of the line is the setup for the gasket-seat facing operation which involves four lathes. Feeding arrangement permits tool changes without interruption of production. When a lathe shuts down, parts are automatically fed to the other machines.

Accompanying pictures illustrate these features of the integrated production line.

3

Wicker-type conveyor carries the blank through Cincinnati cleaning machinery for wash, rinse, dry, drawing compound application, and drying operations.

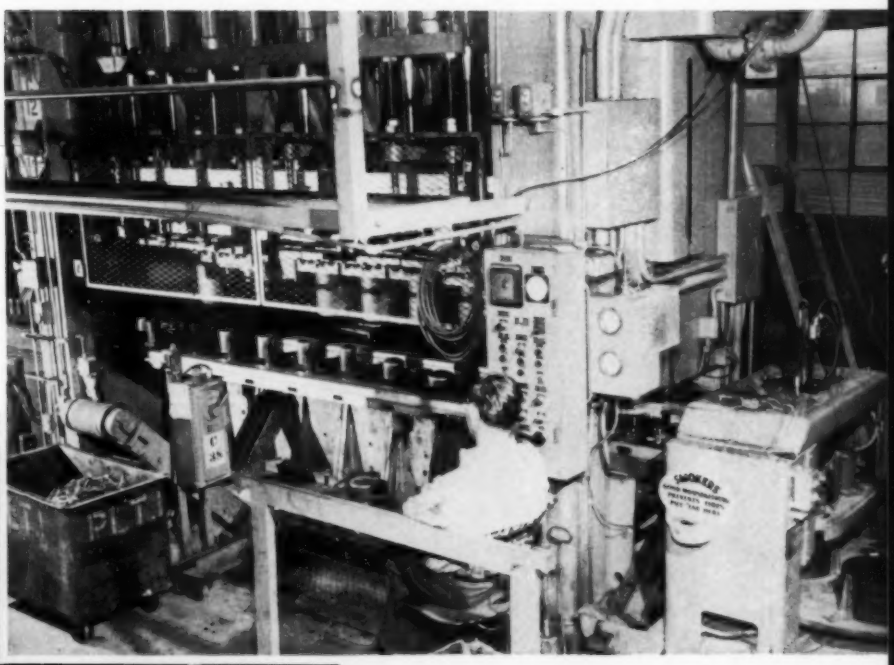


4

Coated blanks move by gravity from the wicker-type conveyor into blank loading device of a transfer press. This device uses opposed magnetic fields to separate the blanks, then positions the blank on the transfer mechanism of the 450-ton press.

5

View of the eight-station Verson transfer press in which the blank is drawn, then pierced and struck.

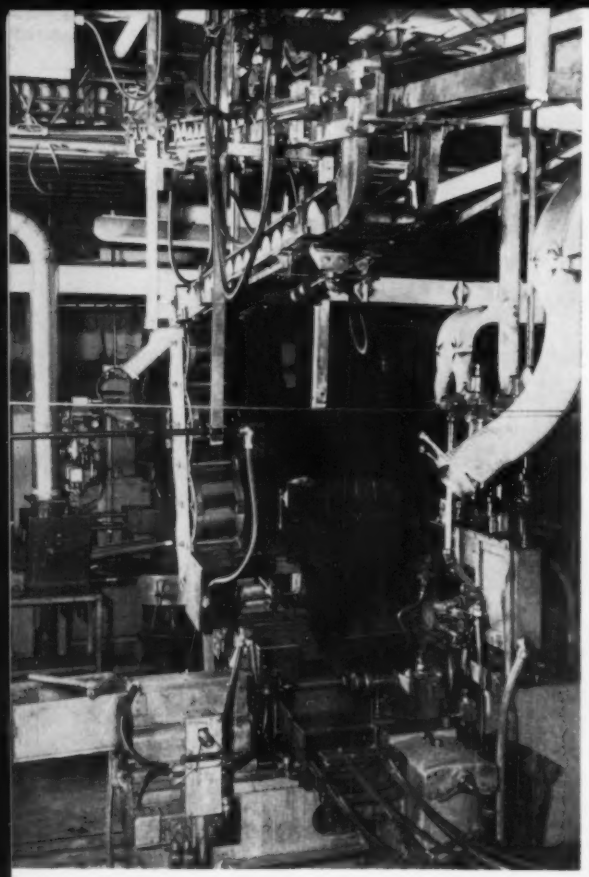


6

Workpiece is ejected from the transfer press and moves into a two-belt friction-type elevator which raises the shell to ceiling height.

7

When elevated, the shell is rotated 90 degrees through the use of gravity and conveyed in an upright position by friction chain to an overhead flat chain storage conveyor. The elevator and storage system were built by Great Lakes Runway Corp. of Chicago. System stops automatically when the 6000 shell storage conveyor is filled to capacity and starts up when partially emptied.



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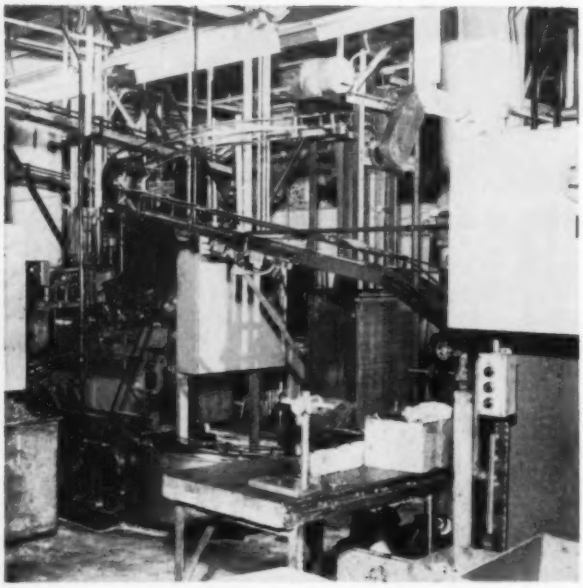
Shell is gravity-fed automatically from the storage conveyor to one of four Sundstrand lathes for a gasket-seat facing operation. The lathes are loaded and unloaded automatically by air and electric controls.



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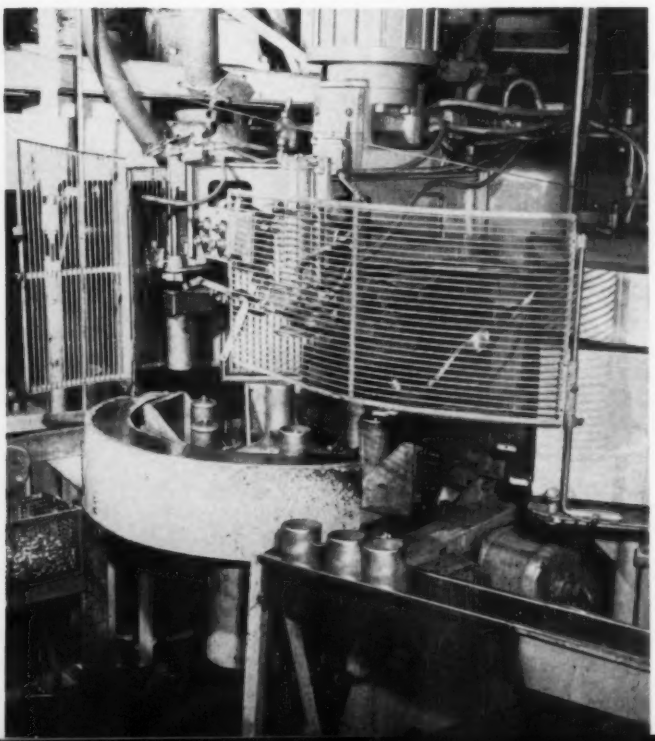
After unloading, the shell is deposited by gravity on a flat-belt conveyor and sent through a Cincinnati washer.



10

From the washing and drying operation, the shell is pre-positioned by an air-operated device and loaded automatically on an indexing welder. United Welding Co. machinery welds the shell's reinforcing ring. These rings are fed from a vibratory hopper (right) and automatically placed into welding position over a ceramic pilot. When this photo was taken, the automatic loading feature was in the installation-debugging stage and loading of the welder was performed manually. After the welding operation, part is disposed automatically to two hand-operated water test fixtures where a leak test is conducted. Then the operator deposits the shell onto a monorail conveyor system which carries it to the next operation.

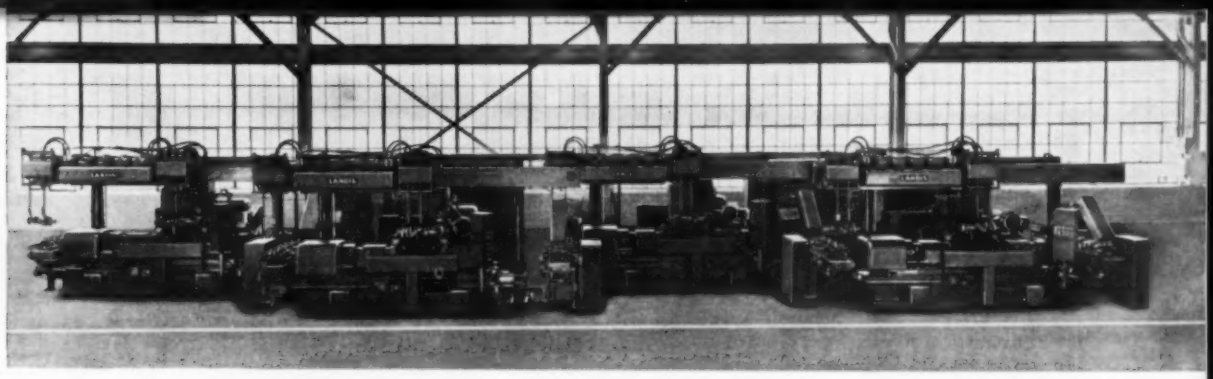


Fig. 1—Line that automatically grinds the crankpins on V-8 crankshafts. Standard crankpin machines are used with suitable interlocking control, handling and gaging equipment.

INTEGRATED LINE USES STANDARD GRINDERS

FOUR STANDARD crankpin grinding machines have been integrated into an automatic line, *Fig.* 1, by Landis Tool Co. to grind the crankpins on V-8 crankshafts to precision limits. Each grinder finishes one crankpin on each crankshaft, so every workpiece passes through the series of four grinders before all of its crankpins are ground. Through provision of handling and gaging equipment and synchronizing controls, production of the four-grinder line is as much as 50 finished crankshafts per hour and the quality level is higher than for manually operated machines.

Each machine is served by a handling device which picks up a crankshaft to be ground, positions it in two chucks, picks it up after grinding, and moves it to a post-process gage and conveyor unit. The machine loading and unloading device is an overhead bridge arrangement with two sets of work carrying arms, *Fig.* 2. One set of arms picks a workpiece up from the incoming conveyor and positions it in the chucks; simultaneously the other set of arms picks the ground part up and moves it to the post-process gage. The part is then held on a conveyor for the next grinder. The handling device for a machine will not operate unless there is a crankshaft waiting to be loaded into the operation and there is an empty space on the succeeding gaging and conveyor unit for the part just ground.

After a part is lowered into the chucks of a machine, the loading arms move away and a gaging finger accurately adjusts the longitudinal position of the work in the chucks. The work is then hydraulically clamped in the chucks and rotated while

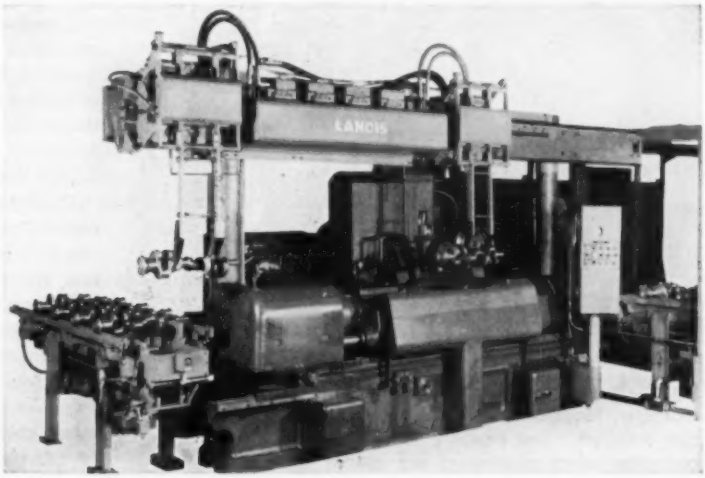


Fig. 2—Flow of crankshafts is from conveyor at left, in and out of grinding chucks, and to post-process gage and conveyor at right to succeeding operation. Transfer device does not operate if no work is available or if outlet conveyor is full.

the grinding wheel is fed in. The sidewalls and the OD of the pin are ground, the diameter being ground within limits of 0.0005-inch. Size of the OD is gaged in-process by a double contact air unit, which is automatically positioned on the pin being ground and controls the grinding cycle during feed and spark-out. Stock removal is 0.020-inch from pin OD and 0.005 to 0.007-inch from each sidewall. After desired size is indicated, the grinding wheel is automatically retracted and the chucks are stopped in proper position for the crankshaft to be lifted out.

Retraction of the grinding wheel sets the handling device into action. The work is taken from the chucks and placed in the post-process gaging position, *Fig.* 3. Here the crankpin is automatically checked for diameter, width and taper. If tolerances are exceeded, the grinder which performed the operation is shut down and lights indicate which measurement is out of limits and whether it is oversize or undersize. Visual gages also indicate the inspection sizes so that the operator knows how much correction to make to the machine setting before re-starting automatic operation.

If it is necessary to shut down one grinder for wheel change or maintenance, the crankshafts can bypass that machine and the other three machines can continue to operate. The operation missed by the down machine can then be performed on a hand-operated standby machine.

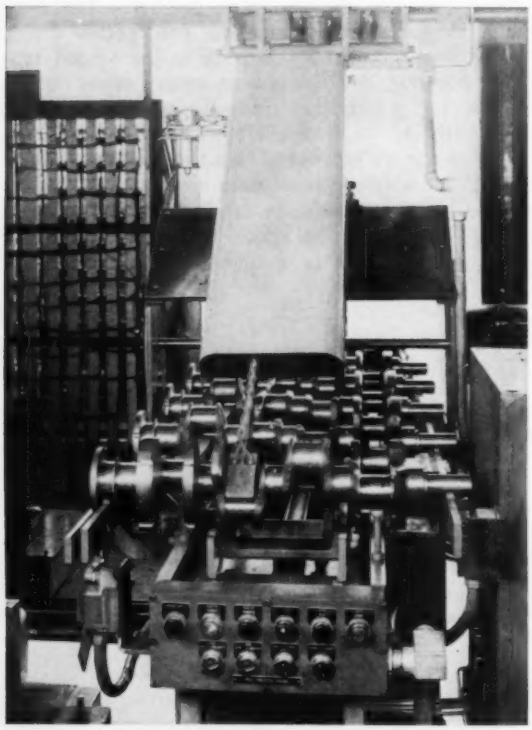


Fig. 3—Post-process gage for each grinder checks the diameter, taper and width of the crankpin ground on that machine. The machine is shut down for manual correction when dimensions are out of limits.

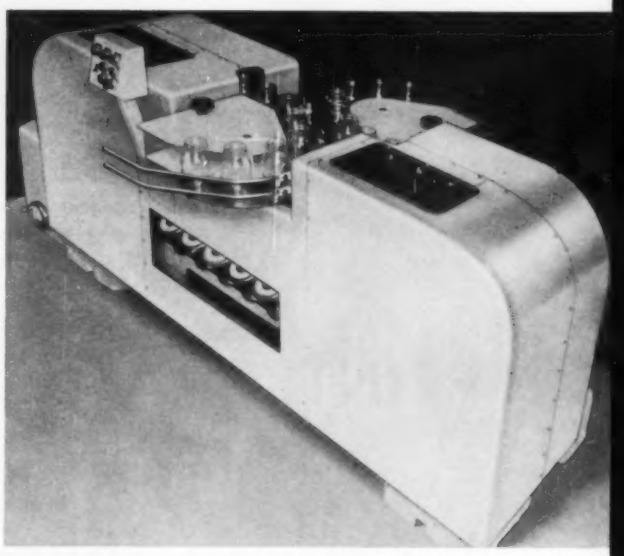


Fig. 1—Machine for cleaning containers before they are filled. Containers enter the machine from an unscrambler conveyor at left and are discharged to a filling machine at right. Machine handles glass, metal or fibreboard containers of various sizes and shapes.

CLEANER FEATURES

FAST HANDLING

EFFICIENCY of any production line is no higher than that of the individual units of which it is composed. This fact is fully appreciated by the manufacturers of packaging and bottling line equipment, and it explains their unceasing efforts to develop improved components for inclusion in their highly automated lines. An example of an improved container cleaning unit for filling lines is illustrated in *Fig.* 1.

Built by Pneumatic Scale Corp., Ltd., and designated Pneumaclean, the device is placed in the filling line between a container unscrambler conveyor and the filling machine. Its function is to remove heavy particles, dust and lint from the containers before they are filled. Designed especially to handle wide-mouthed containers, the machine is also adaptable for cleaning funnel-necked containers such as catsup bottles. Round, rectangular or oval, straight-sided or tapered containers of glass, metal or fibreboard may be run on the machine. Out-

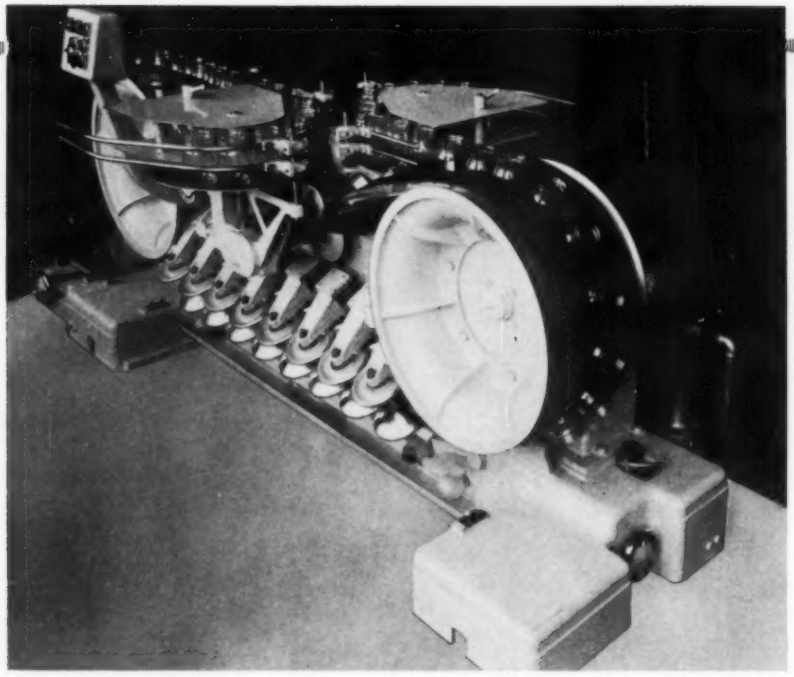


Fig. 2—View of the machine with hoods removed to expose the pneumatically inflated carrier tubes. Combined centrifugal and gravity forces remove heavy particles from the containers as they travel around the drums and in an inverted position along the bottom of the machine.

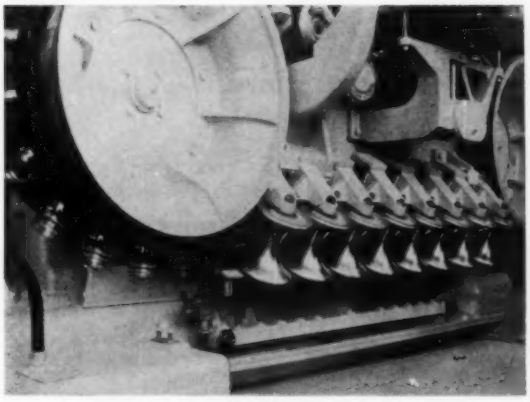


Fig. 3—Closeup showing two spaced series of five air jets along the base of the machine. These blow dust and lint from the containers as they travel upside down.

OF CONTAINERS

put varies with the type of container being run; standard round pint mayonnaise jars can be cleaned at rates up to 500 per minute. For other containers the speed can be adjusted over a 3 to 1 ratio by means of a Varispeed pulley on the drive motor.

As seen in the exposed view of the machine, *Fig.* 2, containers enter the machine in an upright position. They are first carried by a rotating turntable to a point tangential to one of a pair of spaced, rotating drums. Traveling endlessly over the drums is a pair of resilient, pneumatically inflated Neoprene tubes. The containers are fed to and gently picked up between the tubes and are carried through the machine. After cleaning, they are delivered upright to the filler by another rotating turntable which receives the containers from the top of the second drum. Centrifugal force created as the containers are carried around the drums, coupled with the action of gravity as they move in a line upside down, removes heavy matter.

Two series of five air jets along the bottom of the machine, visible in the closeup, *Fig.* 3, blow the remaining dust and lint particles from the containers. An integral dust collection suction fan system is optional with the machine, or existing plant suction lines may be connected.

A single change part and one or two adjustments adapt the machine to handle the complete range of containers. One of the adjustments sets the position of the air jets to suit the height of the container; the other adjustment spaces the Neoprene tubes to give the proper grip. Containers from 2 to 10 inches in height and 1½ to 4 inches in diameter or thickness are permissible.

Having no time dials, stars, or reciprocating elements, the Pneumaclean machine cleans glass and other fragile containers in one continuous, noiseless operation.

FLOW CONTROL IN PNEUMATIC

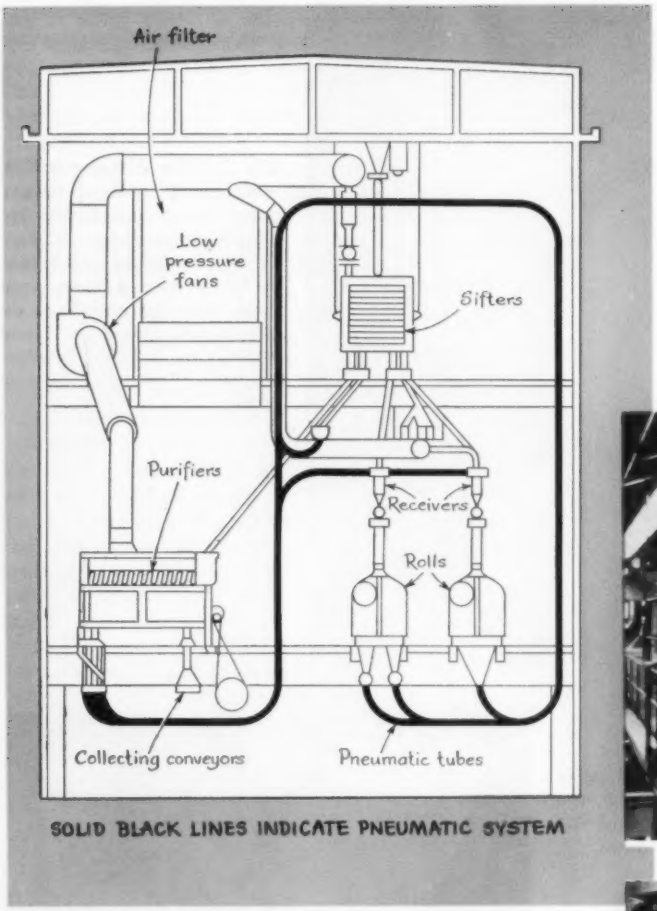


Fig. 1—Sketch of two-story pneumatic mill indicates type of equipment joined together processwise by pneumatic tubes which handle grain movement.

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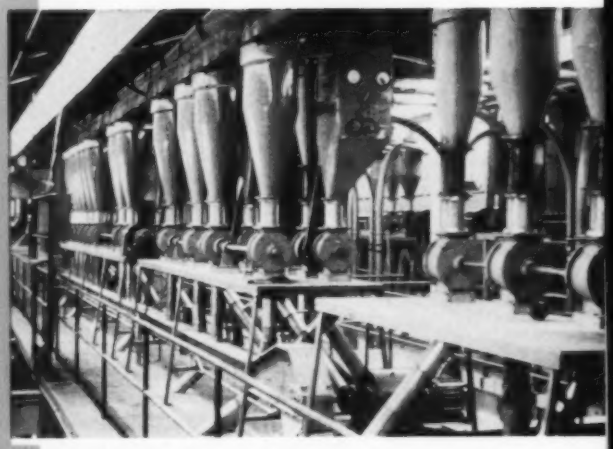

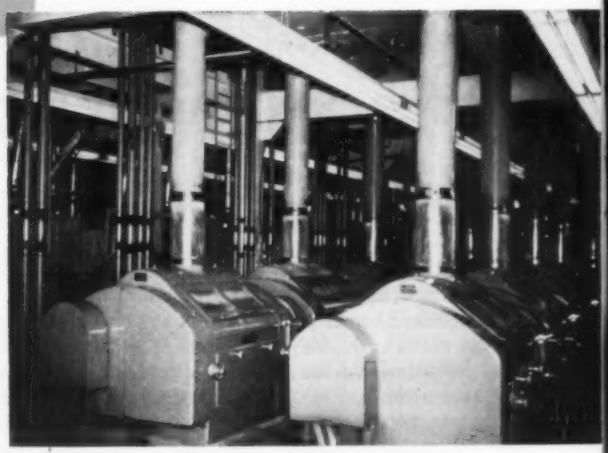

Fig. 2—Grain is directed by tubes to centrifugal receivers or aspirator receivers, and then through air locks to feed ductwork leading to rolls (top). After processing by rolls (center), grain is moved pneumatically to next operation by tubes extending through floor on which rolls are located (bottom). Note the use of common drives for series of air locks beneath receivers and also the use of belts from common shafts for roll drives.

GRAIN MILL

MILLING of wheat or corn is a gradual reduction process whereby impurities and the undesirable constituents of the grain are removed before the nutritive part is reduced to commercial or table size. The grain is cleaned, reduced, classified, and purified on a continuous automatic basis. Each of these operations is repeated a number of times before the desired texture or the granulation is realized. As might be imagined, the type of material handling equipment which conveys the grain between operations is a critical factor in the economical and sanitary operation of a mill.

The field of material handling as related to the milling industry is rather broad. Screw conveyors, drag belts, bulk blow conveyors, bucket elevators, and, the simplest of all, gravity spouts have been in use for generations. In addition to these forms, material is handled by pneumatics and though it has been used in various ways in excess of thirty years it can still be considered relatively new to the milling industry.

Approximately 14 years ago, Buhler Brothers, Inc., Switzerland, designed the first totally pneumatic mill, *Fig.* 1. World War II produced a crippled milling industry in Europe and within 10 years following its end, the Swiss company had equipped over 400 mills with pneumatic elevators and horizontal conveyors. In 1952, the Quaker Oats Co. purchased from this European manufacturer a completely equipped pneumatic corn mill which was installed at Chattanooga, Tenn.

System Details

The pneumatic mill is composed of a series of tubes, each carrying its own stock from one machine to the machine next in its calculated flow, *Fig.* 2 Purifiers, rolls and sifters are the types of machines involved. The tubes vary in size from 2½ to 5 inches in diameter, depending on the weight and volume of the stock they have to convey. Each tube has its own centrifugal or aspirator receiver which discharges the stock being conveyed through an air lock to insure proper air flow. As many as 25 to 30 of the centrifugal receivers vent to a single header which operates at a partial vacuum, varying from 2 to 5 inches of mercury.

The air mover is a single-stage, high-speed, high-static, centrifugal fan which vents between 4000 and 5500 cfm to a suction-type dust collector. To counteract the loss because of the cloth in the filter, additional fan equipment of the low-pressure centrifugal classification is provided, which vents either to atmosphere or to the room in which it is located. The Quaker Oats installation at Chattanooga contains over 70 pneumatic lifts; consequently, there are three systems comparable to the one just outlined.

Isolating one of the 70 odd pneumatic lifts for detailed study has shown that whole grain is conveyed at speeds only slightly in excess of 4400 fpm. A 4½ inch diameter pneumatic line handles 230 pounds of material per minute and conveys at the load of 7.1 pounds of material per pound of air. Since constant feed to the individual mill is imperative, the line is equipped with a constant-airflow regulator. The total drop across the line, including three 90 degree elbows, one aspirator receiver, 40 feet of vertical duct, and 10 feet of horizontal duct has been measured at 53 inches of water (or on the order of 2 psi). Of this loss, approximately 3½ inches of water was measured ahead of the first elbow, which represents the entrance loss of the material to the pneumatic lift. Mill stock leaving the first reduction or first break rolls is conveyed in a 4¼-inch diameter tube at the rate of 100 pounds of material per minute and a material to air weight ratio of 7.5. The loss across the line, which contains approximately the same ductwork as outlined for the whole grain, has been measured at 26.5 inches of water or somewhat less than 1 psi. Of this loss, 3½ inches were measured across the centrifugal receiver. The loss across the centrifugal receivers varies directly with the texture of the material being conveyed and the energy required to precipitate the material from the revolving air stream. These separators vary from 9 to 14 inches in diameter, also depending on the texture of the material and the precipitating energies required.

Control of Velocity

The pneumatic mill is particularly noteworthy because it includes several components which provide solutions to critical pneumatic conveying prob-

The use of pneumatics to move bulk granular material is assuming an increasingly greater role in industry. This article describes a pneumatic grain mill and discusses various components which ensure successful operation of the pneumatic system.

FLOW CONTROL IN PNEUMATIC GRAIN MILL

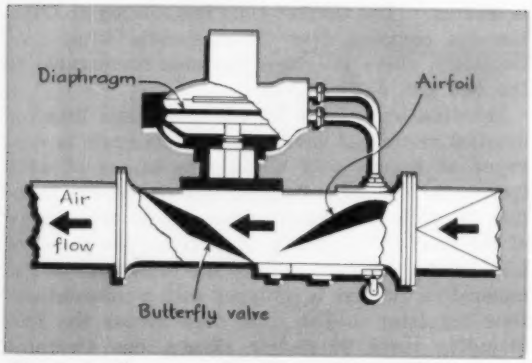

Fig. 3—Air-flow control valve regulates velocity in individual conveying lines. The position of the airfoil is set as desired. Variations in flow create a pressure differential across the airfoil and by means of the diaphragm, actuate the butterfly valve so as to keep the velocity of the moving stream constant.

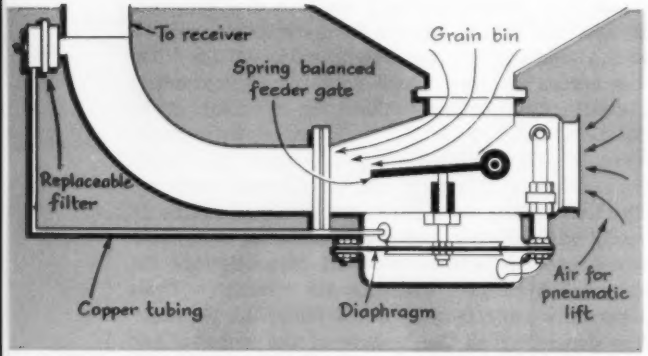

Fig. 4—Pneumatically actuated feeder is designed to control feed rate automatically. Pressure drop between feeder and first elbow is a direct function of load. This pressure is sensed by diaphragm which acts against set tension of a spring in controlling the position of the feeder gate.

lems. For instance, the volume of air pulled in each lift must remain relatively constant on an hour-to-hour basis and the weight of product conveyed in each lift must remain constant and must be fed to the conveying stream at an unvarying rate. A deviation of 10 per cent in either of these two requirements will result in failure of the entire conveying system.

Constant air flow is obtained in the conventional pneumatic mill by a diaphragm actuated valve installed between the receiver and the header to which it vents. This is located on the clean air side of the pneumatic conveying system, *Fig.* 3. The diaphragm is actuated by the pressure differential created as the conveying air passes across a streamlined airfoil. The airfoil or orifice is positioned so that any deviation in a preset pressure differential across its face causes the diaphragm to actuate a butterfly valve. This valve either opens and allows more air to flow through the system or it closes to restrict air flow. The diaphragm will hunt its own position until the pressure differential across the streamlined airfoil has reached its preset value.

The presetting of the airfoil depends entirely on the nature of the product conveyed and is accomplished while the system is in full load. The grain is introduced to the system and a pitot tube with manometer is used to determine the speed of the conveying mixture. The airfoil is positioned to satisfy the requirements of the stream being conveyed at its most efficient conveying speed based on past experience and empirical data. Other things being equal, the volume of air passing through a single pneumatic lift at no load requires more than the power at full load. As the load is added, the resulting mixture produces a decreased volume of air in the system which is directly reflected by the fluctuation of power at the centrifugal fan drive where the power drawn at no load is perhaps 30 per cent greater than at full load. The air-flow control valve serves to keep constant the total power requirements at start-up and full load.

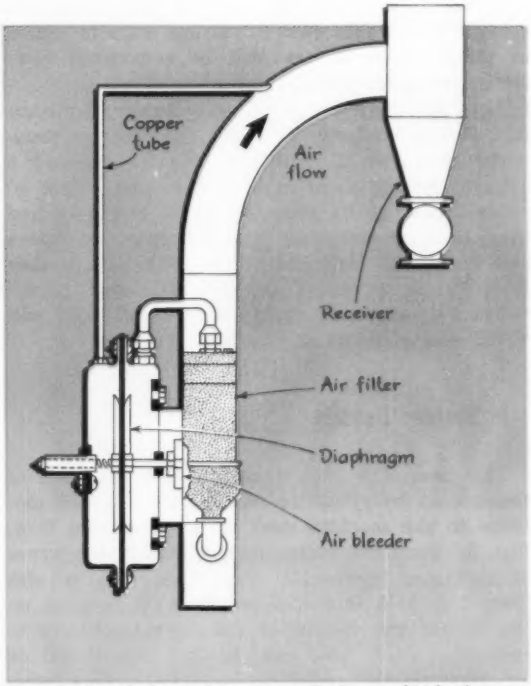

Fig. 5—Antichoking device installed in individual pneumatic lines operates when choke occurs. Pressure across fouled area reaches a maximum and actuates device which allows air to enter ahead of choke zone. This causes clearing and also causes feed control to actuate, keeping grain out of system until normal conditions prevail.

Where as many as 25 pneumatic lifts are venting to a single header, the control element will serve another function. The removal of one lift from the battery of 25 will cause an immediate reaction on the remaining 24. The fan will tend to pull the same quantity of air through the remaining 24 tubes, since the pressure requirements will vary only slightly and, therefore, will increase the conveying velocity within their tubes. This would be undesirable since it would tend to increase abrasion or product damage and consume more power per ton conveyed per unit of time. With an air-flow control device being applied to all pneumatic lifts, each maintains its original air flow, since the pressure differential across the individual airfoils will cause immediate adjustment for the redistributed air flow.

Feed Control

To control the weight of product introduced into each lift, grain bins are equipped with a pneumatically actuated feed valve containing a movable feed flap which can be opened by a strong spring and closed by the applied force of the diaphragm, *Fig.* 4. The flap or slide is spring-held at its normally open position. The control unit functions on the principle that the pressure developed at a point just behind the first 90 degree elbow in the lift varies almost directly as the load passing through the elbow. One side of the diaphragm is connected through copper tubing to this point, and the pressure developed as the line is loaded tends to counteract the spring tension. In so doing, the quantity of feed is reduced and after a preset maximum load is reached, the feed rate will remain constant. The setting of this control also is performed at full load, based on past experience and empirical data, and once made, the feeder under normal operating conditions will never exceed its maximum feeding rate.

The two controls which have been described complement each other under full load conditions, more or less guaranteeing that the vertical or horizontal pneumatic conveying system is carrying a constant load and, even more important, that the line is carrying its maximum capacity and is therefore functioning at its most efficient level.

Control of Chokes

Another major problem involves the restarting of a pneumatic system after an unforeseen shutdown which results in choked lines. The pneumatic mill contains a control device which automatically opens a fouled line. This control, *Fig.* 5, admits room air to the fouled conveying line downstream from the usual choke area, which is at the first elbow in a line. The diaphragm on this pneumatic control is connected directly to a cover plate which opens to admit air to the line or closes to make the system air tight. The diaphragm is actuated by the pressure differential created between any two

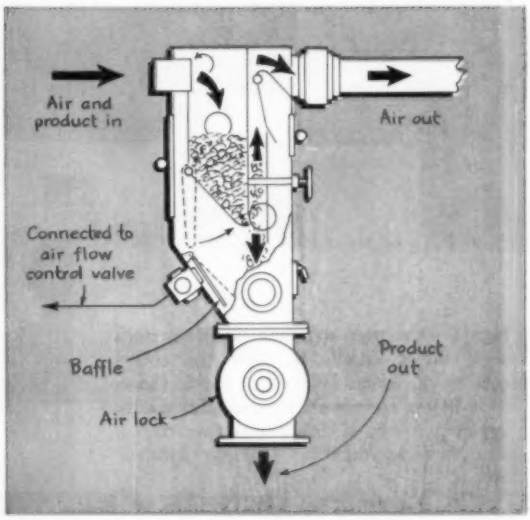

Fig. 6—Aspirator receivers are provided with choke protecting devices which operate when level of grain is such as to depress baffle. The unit operates a valve connected to the air-flow control valve, Fig. 3, causing air flow to stop until the grain in the receiver is at a satisfactory level.

succeeding points in the line which, under choked conditions, is at maximum. By the admission of air to the line ahead of the choke zone partial removal of the feed in that area occurs. This action also automatically causes the control of the line feeder to close, allowing the line to clear itself further. As the pressure differential across the antichoking control diaphragm decreases, owing to the removal of the constriction from the line, the air-bleeder valve closes and the feeder begins once more to load the pneumatic system.

A fourth type of control is mounted in the aspirator receiver, to handle choke conditions at its air lock or any point succeeding it, *Fig.* 6. The control automatically short-circuits the air-flow control valve, immediately stopping the flow of air to the pneumatic lift. This is essentially a level indicator which monitors the quantity of grain in the aspirator receiver.

The value of these control components to the operation of the pneumatic system is most apparent when alternate solutions to the same problem are considered. For instance, one way to counteract these problems would be to oversize the pneumatic system itself. This would allow a certain amount of contingency in the mill designer's calculations and would result in a minimum number of shut downs due to choked lines. Unfortunately, however, the mill's operating cost would increase substantially even to the point of being prohibitive without even considering the increased initial cost of equipment and buildings. In view of the cost of operating an oversized and inefficient pneumatic system, the value of the controls which serve to make pneumatic conveying practical is apparent.

Fig. 1—First step in producing steel bolts and nuts is usually to clean the coiled rod stock which is used. Photo shows coils being positioned on racks for cleaning by pickling. Clean stock is then drawn into wire suitable for fastener fabrication.

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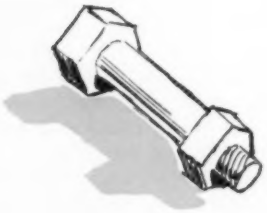


Fig. 2—Stock to be hot formed into blanks for nuts is fed through Tocco induction coils, center, and into the nut former which the operator is watching. The two control stations above the heating units are for the high frequency generators. The panel at right contains the temperature recorder and automatic controller.

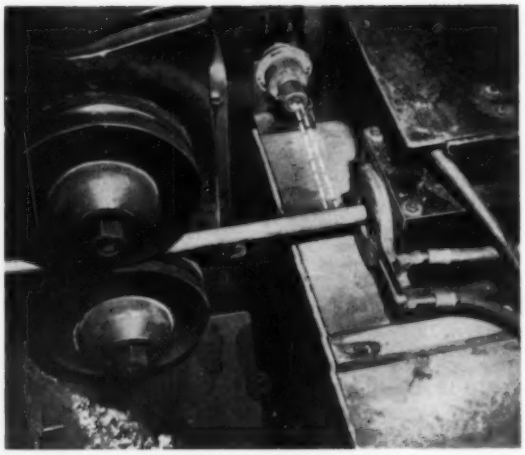


Fig. 3—Temperature of the steel leaving the heating coils is sensed by a Leeds & Northrup detector which is sensitive to radiated heat. Line of sight used in this installation is indicated by dashes.

Fig. 4—Steps in the forming of a nut blank produce these forms. All of these steps are automatically performed in a single machine.

A PICTORIAL REPORT . . .

MAKING THREADED FASTENERS

AS THE REQUIREMENTS of a job to be done have gone beyond the ability of a man to accomplish the task, machinery has been developed to aid him. In the fastener industry one can now see a single automatic machine taking strands of steel perhaps ¾-inch in diameter, cutting a piece off every second, squeezing it in dies, upsetting a lump on one end, trimming it to form a bolt head, and rolling a thread on the other end. When automatic handling equipment is used to take the product to succeeding automatic operations, storage, or directly to a shipping container, a minimum of hand operations may be obtained. But the automatic factory is still in the future for the fastener industry. Brains have not been built into the machines; men must still set up, adjust and supervise. The effect of machinery development and evolution has been to increase the productivity of men, not eliminate them.

Types and sizes of fasteners run into the thousands. Variety of operations is the rule rather than the exception. In contrast to an automated line producing one product design over an extended period, equipment in the fastener industry must be versatile. Although production orders of many "specials" run into the millions, a million pieces may only be a run of a few weeks. The fastener industry is thus a fertile field for ingenious engineers. Do it better and cheaper; combine operations, mechanize and automate; but keep it versatile. Today's automatic machine, if too specialized, is tomorrow's white elephant in the fastener business.

Some of the equipment features of present Lam-

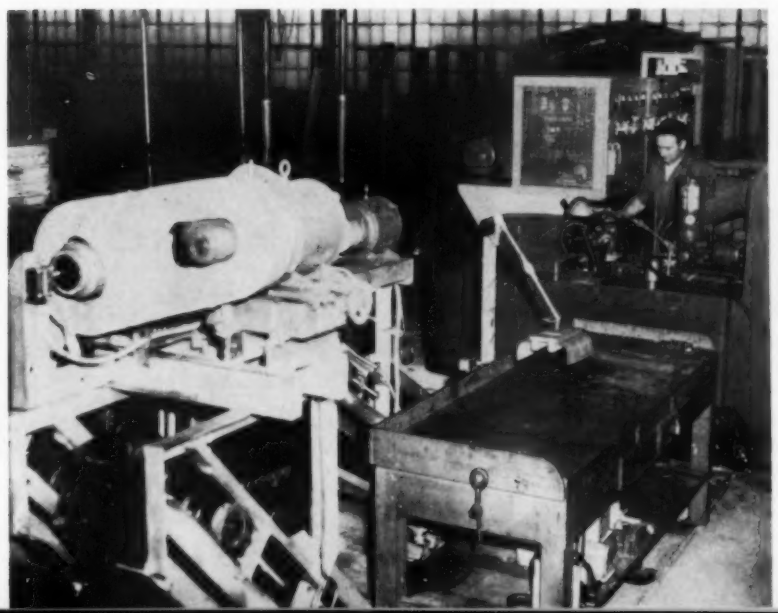


Fig. 5—Finished nut blanks drop out of the nut former into a quench tank under the floor and then travel up the elevator conveyor at left which dumps them into portable drop bottom bins.

son & Sessions Co. plants are shown in the accompanying photographs. In various installations, machines are equipped with hopper feeds, drop bottom bins being used to feed many of the hoppers; stack bins are also used to load hoppers and for transport; conveyors remove products from machines and are also used for transport and storage of such purchased items as shipping kegs. In one nutmaking operation, steel is fed automatically through heating coils to a hot nut former—from cold steel to nut slug in 90 seconds at the rate of 6000 per hour. Pictures shown were taken in present plants, but many of these ideas are being carried to a new and modern plant now under construction.

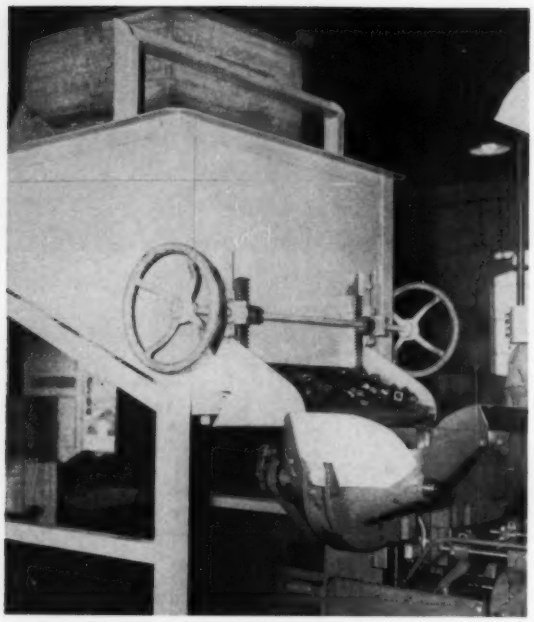


Fig. 6—Drop bottom bin empties nut blanks into a stationary bin which supplies a hopper feeder mounted on a tapping machine. Flow of the nuts through the tapping operation is automatic. In the case of some machines a belt conveyor takes the tapped nuts to overhead storage bins.

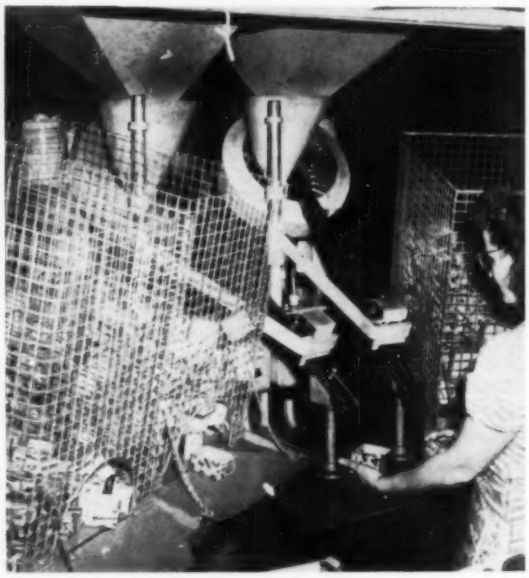


Fig. 7—Nuts move from the storage bins through selector hoppers which feed nuts to galleys or chutes. A gate in each galley controls the number of nuts released into a package when the operator trips a button.

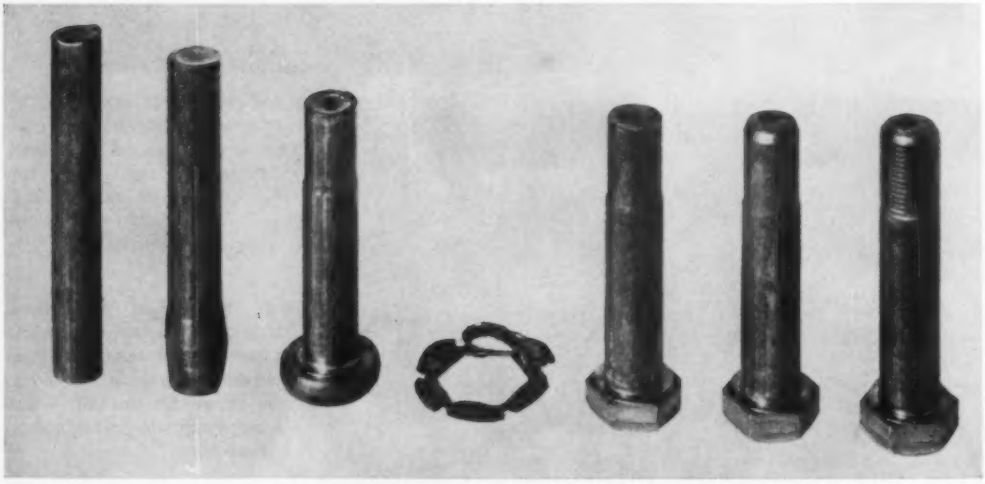


Fig. 8—Stages in the production of a bolt in the boltmaker are shown by these blanks and the finished part. Operations are performed without external heating, but the bolt becomes quite warm as a result of the forming operations.

Fig. 9—This large boltmaker is capable of making ¾-inch bolts and is driven by a 75-hp motor. This machine can cut a blank from coiled lengths of wire, upset the head, trim the head to shape, point the thread end, and roll form the threads, all automatically in a series of integrated operations.

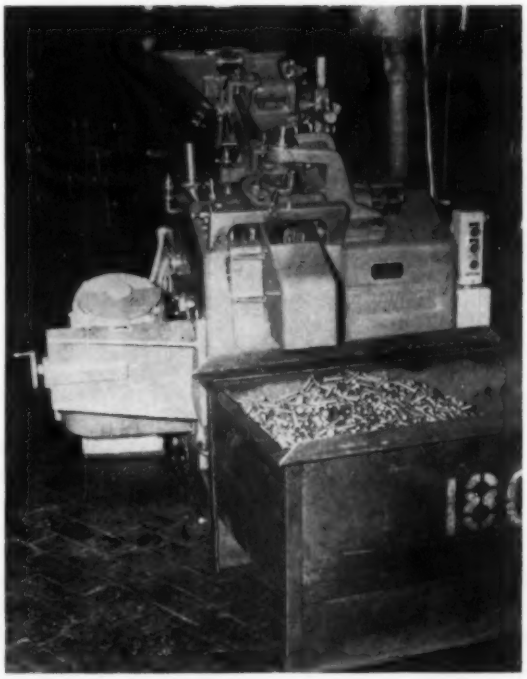
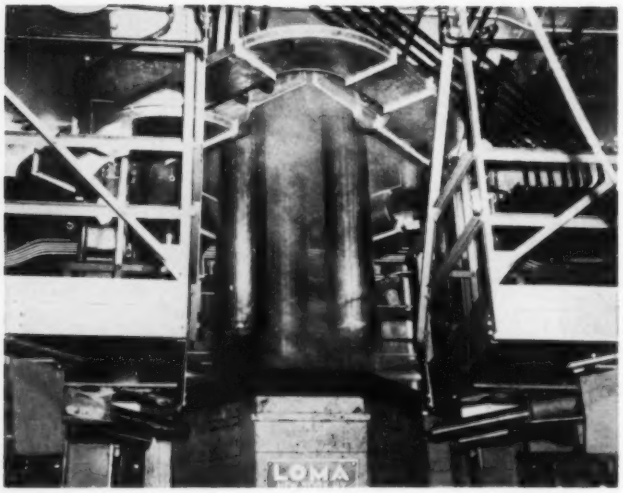
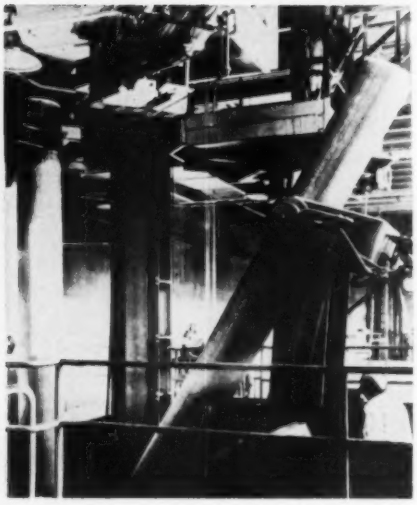


Fig. 10—Some bolts are not pointed on a boltmaker, but may be fed from an oscillating blade type feeder to a special pointing machine such as this one.

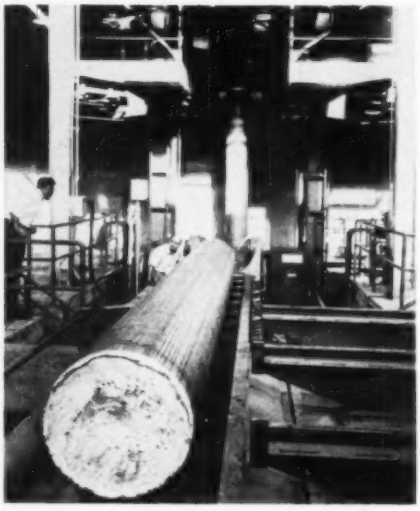
Fig. 11—This is a marshalling yard for items coming on gravity conveyors from heat treating, plating or washing. The circular conveyor stores material from the various departments. At right is the top end of an automatic elevator which handles pans or kegs and feeds them to the proper exit conveyor (inset). The elevator cycles automatically and its destination is automatically established by the type of container it is carrying.

CASTING ALUMINUM LOGS





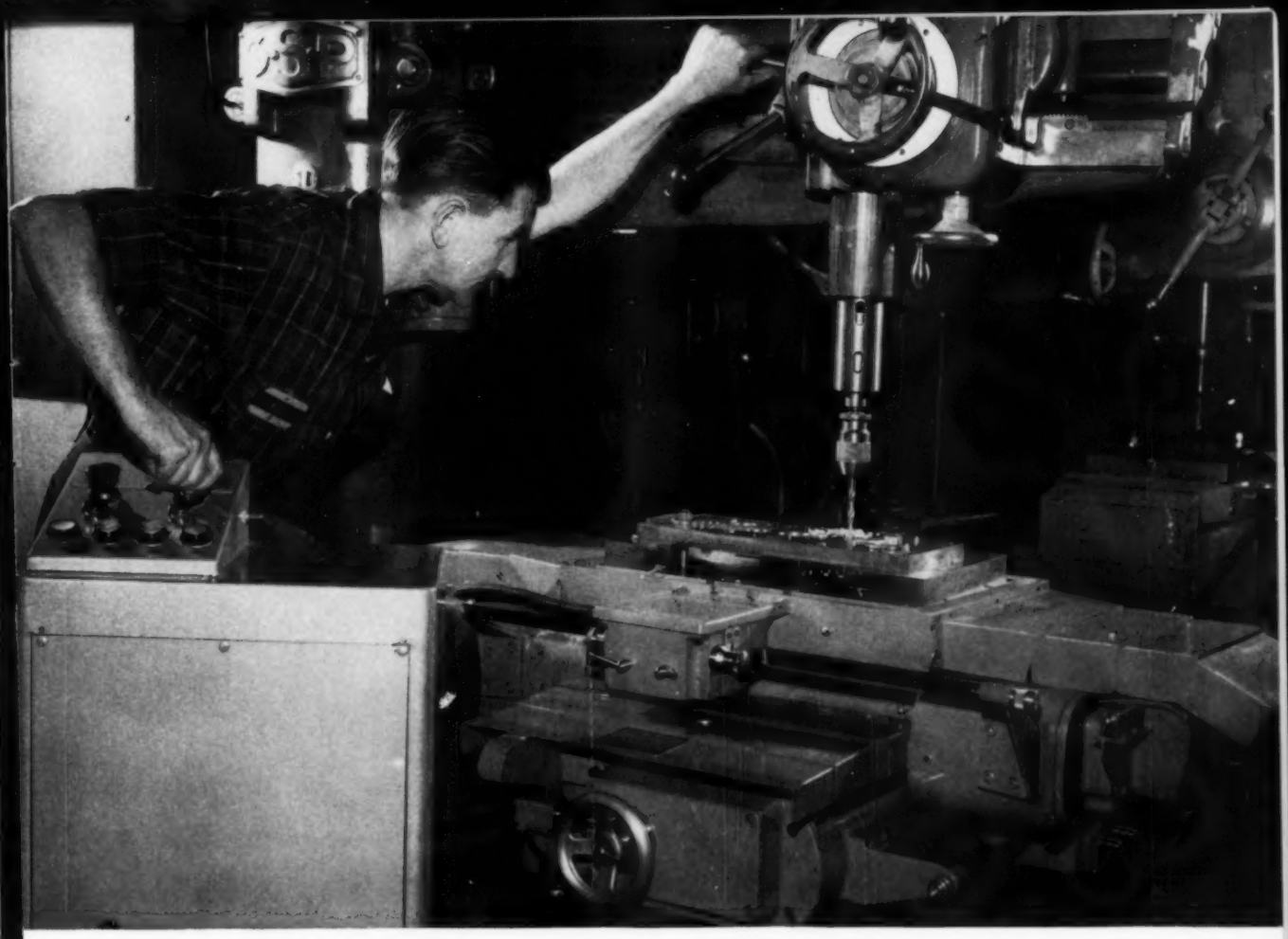
Molten aluminum is poured into water cooled molds out of sight at top of picture (above). Mold stools on movable platform below the molds support the cast logs and control the rate of withdrawal from the molds. As shown (left), an arm grips each billet and lays it down on a gravity roller conveyor (below).



CAST ALUMINUM logs or billets are used at the U.S. Air Force Heavy Press Extrusion Works operated by Kaiser Aluminum & Chemical Corp. at Halethorpe, Md. These billets are produced at this plant on special semi-continuous casting machines capable of producing logs up to 25 feet long and up to 20 inches in diameter. Two machines built by Loma Machine Mfg. Co. are used to cast two or more logs simultaneously in a vertical pour, direct chill operation.

Hot metal for the casting operation is fed from four gas-fired reverberatory furnaces. The metal flows from the holding hearth of the furnaces, through a refractory-lined and electrically-heated swinging trough, into a distributing pan, and through spouts into the water-cooled molds. The bottom of each billet is supported by a mold stool and lowered from the mold at a controlled speed which may be as fast as 8 inches per minute. The mold stools are supported by a platform positioned by a hydraulic cylinder having a stroke of almost 30 feet. The platform can support a maximum load of about 20,000 lbs.

When a pour is completed, the billets are supported in their vertical positions by guides. A hydraulically actuated billet grab arm is then advanced and made to pick up one billet at a time. The entire billet removal device is mounted on a carriage which moves on rails. Simultaneous tilting of the billet grab arm and movement of the carriage away from the casting machine lays the billet down. The cast log is then unloaded to a gravity roller conveyor which incorporates a 5-ton weighing scale. Finally, the log is pushed onto a billet receiving rack where it is reflectoscoped and then transferred to either a billet saw or homogenizing furnaces.



cuts set-up time,
eliminates jigs and fixtures
on repetitive drilling,
reaming, tapping and
many other operations

MICRO-POSITIONER

tape controlled indexing table

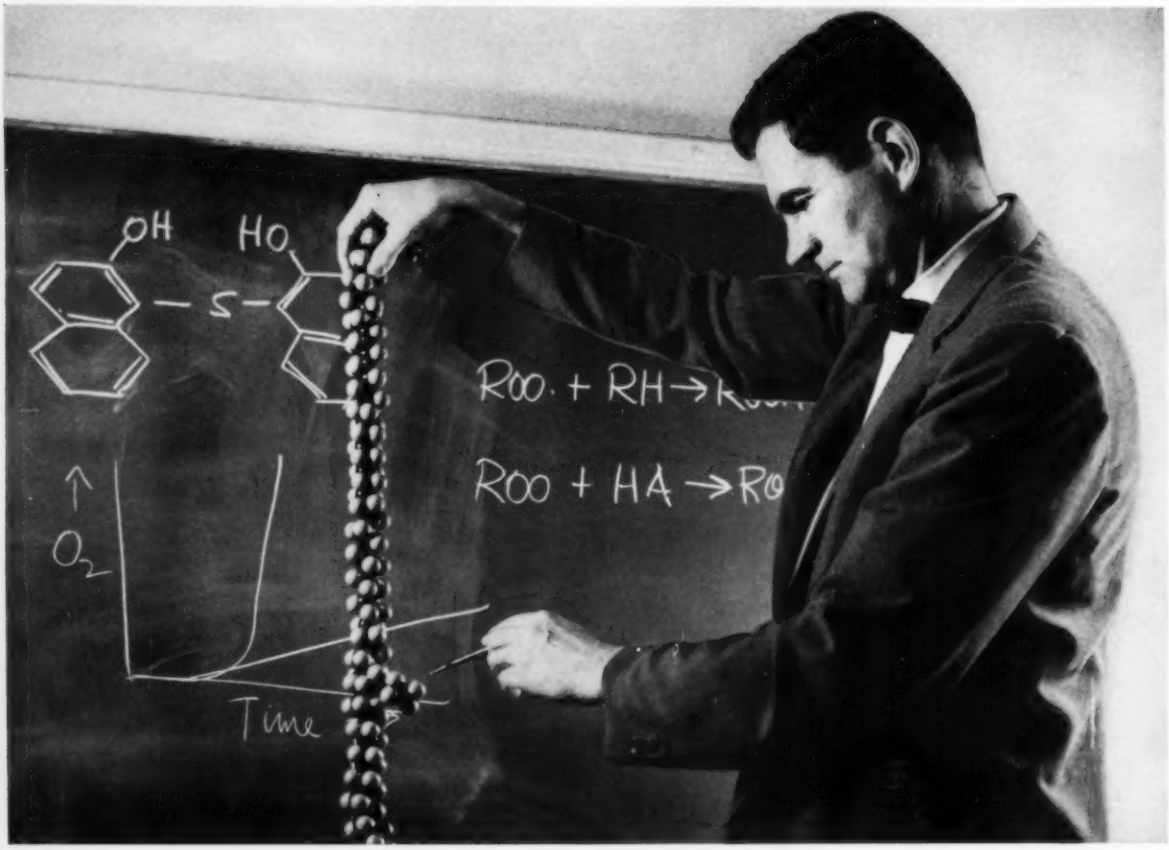
The "MICRO-POSITIONER", automatic indexing table, has effected positive accuracy to .001" by providing an external, visual means of adjustment for indentation sensing and tape relocating. Also, an indenter safety switch prevents any possible indenting unless the tape is installed and mechanism is in indenting position. This table is precision made, simple, fully electric and push-button controlled. It makes possible reproduction of complex drill or tapping patterns repetitively and swiftly with very little effort or skill required from the operator. In operation, one tape controls the transverse movements of the work table and a second tape, the longitudinal movements. These movements are controlled electro-magnetically by an electric clutch which makes split second starts and stops of the lead screws as the switches sense the markings on the tapes. It is compact in design and relatively lightweight. Thus, it may be quickly moved from one machine to another as necessary. When used in combination with radial drills, milling machines, turret drills or other suitable spindles, the "Micro-Positioner" results in a universal production machine of unlimited potential.

For complete information, write A-9

MICRO-POSITIONER DIVISION
710 Wilshire Boulevard, Santa Monica, California
TOPP MANUFACTURING COMPANY

Telephone: EXbrook 4-0373

Circle 677 on Inquiry Card



Bell Laboratories chemist Field H. Winslow, Ph.D., Cornell University, with a scale model of a small section of a polyethylene molecule. Branch formation indicated by pencil is vulnerable to oxidation. Dr. Winslow and his associates worked out a simple way to protect long polyethylene molecules needed for durable cable sheathing.

THE DILEMMA OF GIANT MOLECULES

Solution: 2 plus 2 equals 5

Polyethylene is used to protect thousands of miles of telephone cables. It is tough, light and long lasting. Its strength lies in its giant molecules—a thousand times bigger, for example, than those of its brittle chemical cousin, paraffin wax.

But polyethylene has a powerful enemy: oxidation, energized by light and heat, shatters its huge molecules to pieces. This enemy had to be conquered if polyethylene was to meet the rigorous demands of cable sheathing. Paradoxically, it was done by making the whole better than the sum of its parts—just as though 2 plus 2 could be made to add up to 5.

To check the ravages of light, Bell Laboratories chemists devised the simple yet highly effective remedy of adding a tiny dose of carbon black. Then antioxidants, such as those commonly used to protect rubber, were added to check attack by heat. But here the chemists encountered a dilemma: although the carbon black protected against the effects of light, it critically weakened the effectiveness of the antioxidants.

To solve this dilemma, Bell Labs chemists developed entirely new types of antioxidants—compounds not weakened by carbon black but which, intriguingly, are very much more effective when carbon black is present. The new antioxidants, plus carbon black, in partnership, provide long-lasting cable sheath—another example of how research at Bell Telephone Laboratories works to improve your telephone service.

BELL TELEPHONE LABORATORIES

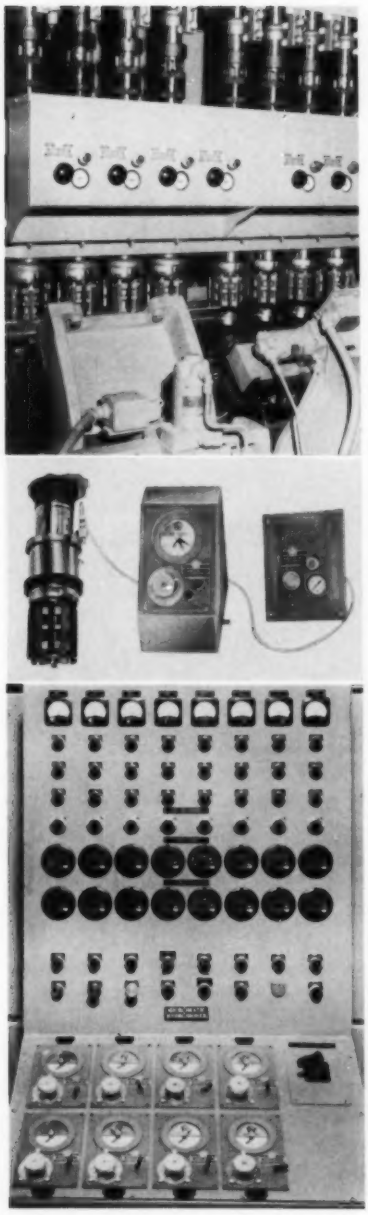
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

AUTOMATION

new equipment

Machines and plant equipment for more automatic operations

For detailed information and literature, use card page 17.



Gage Air Microsize applied to cylinder bore honing. Basic components are: Honing tool, size indicator and adjustor, and circuit regulator. Control panel shows each bore size and provides adjustability.

Automatic Size Control Systems for Honing Machines

THE NEED for controlling the dimensional accuracy of cylindrical surfaces while maintaining a high production rate has led to the development of different methods of automatic sizing on highly automated machines by the **Micromatic Hone Corp.,** 8100 Schoolcraft, Detroit, Mich.

To obtain maximum production and quality the microhoning equipment was designed to suit the part being processed. Four types of size control are given as examples of those in common use.

Gage Ring Microsize

A means of automatically controlling diametric size where the tool functions as an expanding plug. The tool rotates and reciprocates through the bore, while plastic encased abrasives are forced out radially to keep in constant contact with the work surface. As the self-dressing abrasives shear stock from the bore, the plastic wears at the same rate as the abrasive. The diameter of the tool is exactly equal to the diameter of the bore.

A gage ring with an ID equal to the final desired bore diameter is mounted above the workpiece. It is positioned so the plastic tabs on the ends of the abrasives enter the ring at the top of each stroke. When the bore and the tool are the same diameter as the ring, the friction between the rotating plastic tabs and the gage ring causes the ring to turn through a small arc. This movement of the ring triggers an air switch or an electronic pickup initiating the sequence that ends the honing cycle.

Characteristics of the gage ring system are: Assured geometric accuracy; small diameter bores can be easily sized, and diametric accuracy of 0.0003-inch or less.

Gage Bar Microsize

The bore is gaged by two bars that float on the body of the tool. A spring pressure holds the bars out against the bore. The distance between the contact faces of the bars is the measure of the bore diameter. These bars are fastened to a split ring, hinged at a point 90 degrees from the bars. Opposite the hinge are two low potential electrical contacts.

When the tool enters a rough bore the bars are pressed in and the contacts are held apart. As the bore is microhoned the contacts move closer together. When the bore is "to size" the contacts meet and the cycle is terminated.

Characteristics of the gage bar system are: Diametric size can be accurately held as contacts are adjusted for bores varying 0.040 in diameter; all elements are carried on tool and no brackets required; it can be used on large diameter bores 4 inches and over.

Gage Plug Microsize

A plug with an OD equal to the desired bore diameter is attached to a concentric metallic bellows. It can be mounted around the drive shaft of the tool or, in case of a horizontal machine, it can be mounted at the opposite end of the bore. The pressure that causes the plug to try to enter the bore is the result of air expanding the bellows as the tool strokes through the bore. The flexibility of the bellows provides "float," permitting the plug to align itself with the bore. When the workpiece is microhoned to the desired size the

plug enters the bore. This triggers a switch in the air circuit and terminates the cycle.

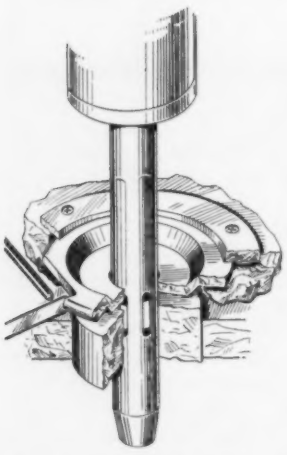
Characteristics of the gage plug system are: It can be used on deeply counterbored parts; it is not affected by the stroking speed; its accuracy is 0.0003 inch.

Gage Air Microsize

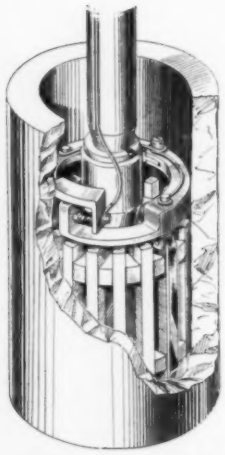
An air gage enters the part on each reciprocation of the tool. The gage strokes with and around the drive shaft of the tool, but floats independent of it. It is slightly smaller than the finished bore diameter. As the bore approaches the desired size the gage indicates the diameter on a dial. When there is the proper clearance between the gage nozzles and the bore, the decreased back pressure drops out a pressure switch and initiates the sequences that end the cycle.

Characteristics of the gage air system are: Diametric accuracy of 0.0002-inch; adjustability holds accuracy through a range of 0.004-inch; and remote adjustability while the machine is in automatic operation.

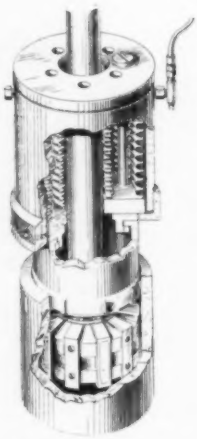
—*Circle 401



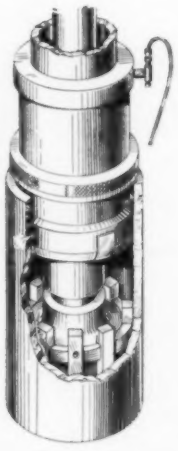
Gage Ring Microsize assembly and workpart, showing the tool at the top of its stroke. Only the upper plastic tabs of the abrasive assembly enter the gage ring. These tabs contact the ring which flexes the leaf spring to initiate the impulse.



Gage Bar Microsize tool in unfinished bore, with electrical contacts held open. Contacts come closer together as stock is being removed and meet when final size is reached. Closing of contacts terminates honing cycle at required size.



Gage Plug Microsize assembly and workpart, showing the gage plug just entering the workpart. The concentric bellows permits the plug to float with the tool but to remain independent of the force of the stroking speed.



Gage Air Microsize in action. The tool is at the bottom of its stroke. One of the air orifices is seen as the air gage enters the workpiece; through decreasing back pressure, the diameter begins to register on a dial on the control console.

Barrel Plating Machine

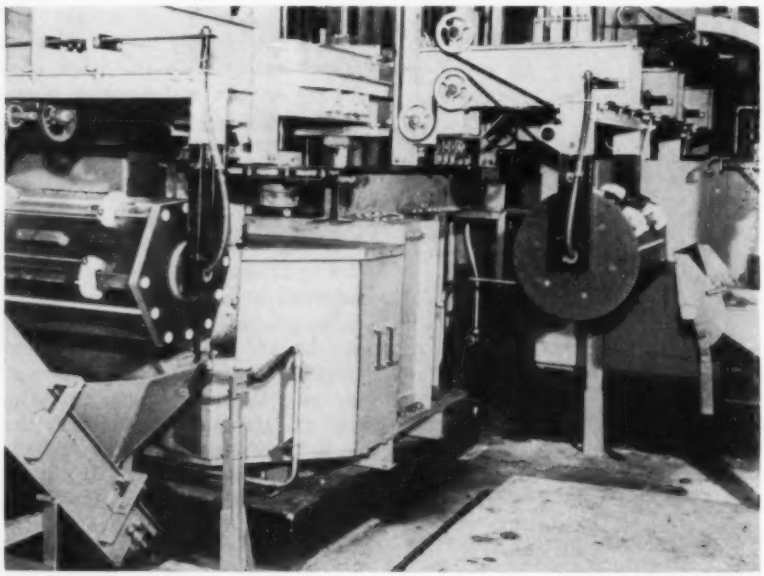
Item 402—

Unit offers variable cylinder rotation speeds and centralized cycle control. System has a return-type conveyor which allows a continuous flow of small parts and hardware from the production department or loading dock, through the machine and back again, without pile-up or manual handling.

Mercil-type barrels are driven by a constant-tension v-belt and pulley arrangement. By providing gang drives at each section of the machine, the cylinders change rotation to match the tank requirement, eliminating the need for multi-speed motors on each cylinder frame.

Cycle Selection

A flag arrangement on each cylinder hanger allows the operator to select the proper cycle for the contents of the barrel without leaving the central station. In the raised position, the flag contacts a limit switch at the tank to withhold the cylinder from that particular bath. Each cylinder follows an independent cycle and unlike loads can be placed in ad-



*For Inquiry Card, see page 17

GENERAL ELECTRIC ANNOUNCES

New Totally Enclosed D-c Motors

KINAMATIC* . . . to meet modern needs for faster, more automatic production in severe environments, General Electric announces a complete line of totally enclosed direct-current motors.

Designed for Tough Duty, d-c Kinamatic enclosed motors give you maximum mechanical protection *plus* the wide speed range and versatility required for close control of machines and split-second timing of processes.

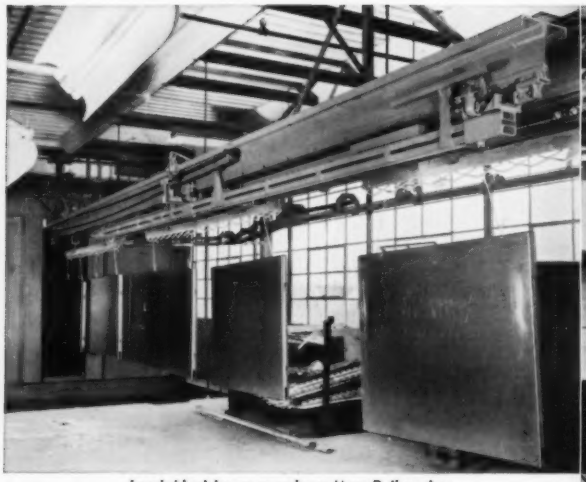
Standard Mounting Dimensions of enclosed d-c Kinamatic motors save you time and money. With this better protected, more powerful direct-current motor, your machines will operate with less downtime . . . faster . . . easier . . . and with less maintenance.

Additional information is available at your nearest General Electric Apparatus Sales Office. Or, if you prefer, write for Bulletin GEC-1372, *Direct Current Motor and Generator Department, Erie, Pennsylvania.* 813-10

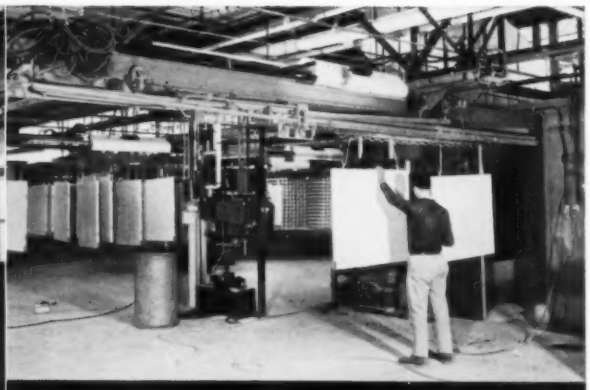
*Trade-Mark of the General Electric Company.

Progress Is Our Most Important Product

GENERAL ELECTRIC

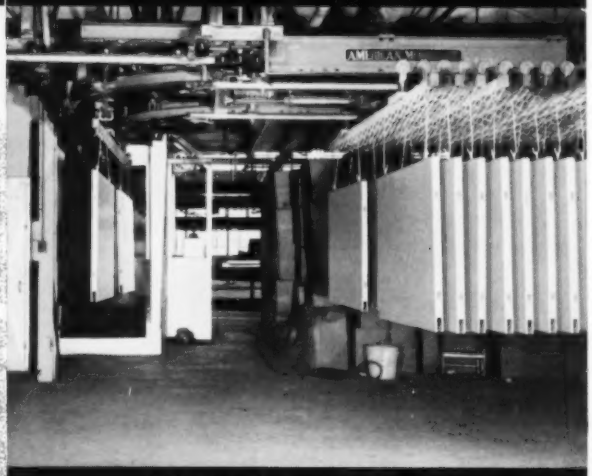


Landahl picks up panels as MonoRail pushes them from degreasing



MonoRail pneumatically pushes a "car" of panels into a finish spray booth.

Automatic Finishing with Power LANDAHL and AMERICAN MONORAIL



Finished panels are pushed by MonoRail from the bake oven.

Space was saved and automatic finishing achieved by combining two overhead handling systems.

American MonoRail cars carrying metal panels move through degreasing, priming, finishing and baking. In each operation either loading or unloading is performed automatically by power — the Landahl Chainless Conveyor acting as a "pusher" over most of the system.

Here is "team work" engineering to take advantage of the flexibility of both American MonoRail and Landahl Chainless Conveyors.

This efficient system is installed at Fostoria, Mfg. Co., Fostoria, Ohio, for finishing metal panels for office partitions.

For details on how American MonoRail or Landahl Conveyors can cut your handling costs, write today.

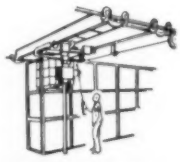
Member of The Materials Handling Institute, Inc. & MonoRail Manufacturers' Association.

For Power Driven Conveyors, Use Landahl Chainless Conveyors

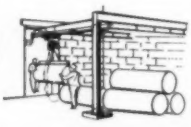
AMERICAN MONORAIL COMPANY

13144 ATHENS AVENUE, CLEVELAND 7, OHIO (IN CANADA—CANADIAN MONORAIL CO., LTD., GALT, ONT.)

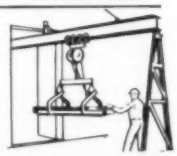
AUTOMATIC DISPATCH



STACKER CRANE



MANUAL MONORAIL



RETRACTABLE CRANE

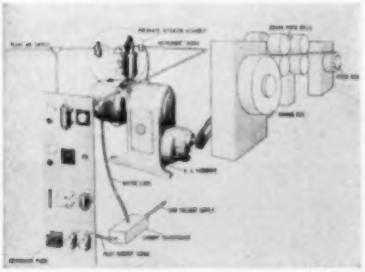
jacent cylinders and the proper cycle selected for each one at the time of loading.

Variable Barrel Rotation

A drive shaft on the conveyor transmits power through a gear train to a belt and constant tension pulleys on the barrel hangers. The barrel rotates during the lift for draining, the immersion into the tank and while traveling through the solution. Barrels are designed for total submersion during the plating process to increase plating speeds and insure thorough deposition. The belt drive does not come into contact with the solutions at any time.

Cylinders are available in various materials and attachments. **Hanson-Van Winkle-Munning Co.,** Church St., Matawan, N. J.

—*Circle 402



Rewind Tension Control

Item 403—

Variable speed is obtained by reducing the speed of the Varidrive unit as the rewind roll diameter builds up. Tension remains within 5 per cent of any preset required value or can be tapered up to 50 per cent less tension at the finish than at the start of the roll.

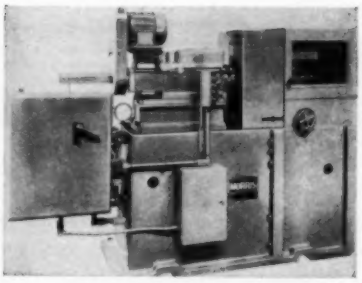
Units are available in a range of 1 to 50 hp and speed ranges up to 7 to 1. **U. S. Electrical Motors Inc.,** Box 2058 Terminal Annex, Los Angeles 54, Calif.

—*Circle 403

Gun Drilling Machine

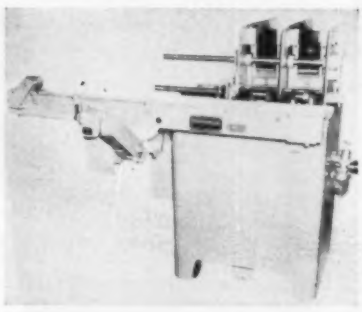
Item 404—

Variable spindle speeds and feeds, adjustable automatic load control and a co-ordinated high pressure coolant and chip removal system are features of the gun drilling machine. Capable of drilling deep holes 1/8-inch diameter and up, unit is also suitable for shallow holes where straightness, size and finish are required. Spindle speeds up to 8000 rpm are made with a simple adjustment. Feeds up to 40-inches per minute are possible with adjustable feed stroke available in 6 or 9-inch stroke.



An adjustable load control protects the machine against breakage of gun drills or workpieces. It automatically detects dull drills, chipped drills, hard spots in the material or insufficient coolant. A co-ordinated system, consisting of a rear inductor pump and gage and filters, produces coolant pressures up to 1000 psi. The quill is supported at both the front and center of the unit, assuring straight line motion of the quill during the feed stroke. **Morris Machine Tool Co.,** 933-17 Harriet St., Cincinnati 3, Ohio.

—*Circle 404



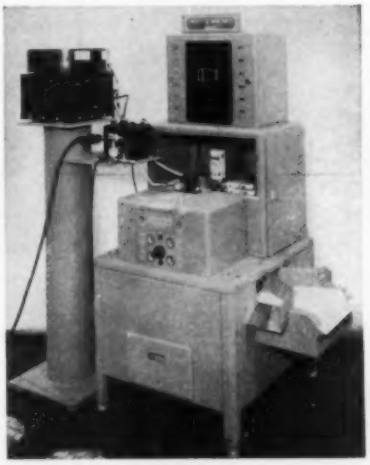
Automatic Bar Feeder

Item 405—

Unit is suitable for feeding a wide range of parts in a continuous flow into drilling machines, milling machines and high speed equipment. A dual automatic feed operates 50 pieces per minute in a continuous stream of oriented parts flowing into a centerless grinder. Two feed chutes arrange the parts on an external feed track, orienting them to flow into the production machine at any desired speed. Supported by the hopper base, the track is equipped with automatic cycling controls.

Model 1700 B can be made portable by mounting it on a single base with heavy casters. **Feedall, Inc.,** 38399 Pelton Rd., Willoughby, Ohio

—*Circle 405



Gaging Machine

Item 406—

Unit automatically receives machined parts from an automatic screw machine, gages them on five dimensions, and delivers the sorted good and rejected parts to appropriate boxes. Production rate is 2040 parts per hour. The motor drive unit which is part of the basic machine contains two cam piles driven by a 1/40 hp electric motor. One cam pile moves the feed slides and the transverse slides. The other operates limit switches controlling the automatic sequence of the machine.

A shutter unit directs the measured parts to appropriate channels, then to a conveyor that delivers the parts from the gage to the proper boxes. The workpieces are held by a gaging fixture located on the machine base casting inside the gage head cover. The workpiece is gaged by mechanical contact with carbide tips. All movement is sent by the carbide tips to the microlimit gages, which complete an electrical cir-

*For Inquiry Card, see page 17

OVER TWENTY YEARS OF

Onsrud® innovation and

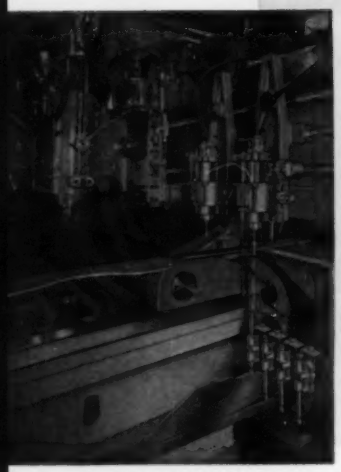
SPECIALLY DESIGNED FOR HIGH-SPEED ALUMINUM MILLING

● Everything Onsrud designs and builds . . . from machine tool components supplied to equipment builders to complete milling machines . . . everything from a 20 ounce high speed spindle to a 100 ton electronically controlled contour mill . . . is made for the specific purpose of milling ALUMINUM and related nonferrous metals. As you plan for new production or review your present methods and machines, if your objective is to find the means of *reducing costs*, be sure to let an Onsrud representative show you the ways Onsrud specialization can help you.

PROVED BY EXPERIENCE

● Onsrud has been a designer and supplier of production milling machines for the aircraft industry for over twenty years. Since 1945 Onsrud has developed a series of special high speed machines now in use in a variety of industries . . . all for the mass production milling of aluminum and other nonferrous metal parts.

Onsrud today has successfully developed and built special electronically controlled milling machines for hyper-speed face, profile and contour milling involving three dimensional and three directional infinitely variable milling feeds.

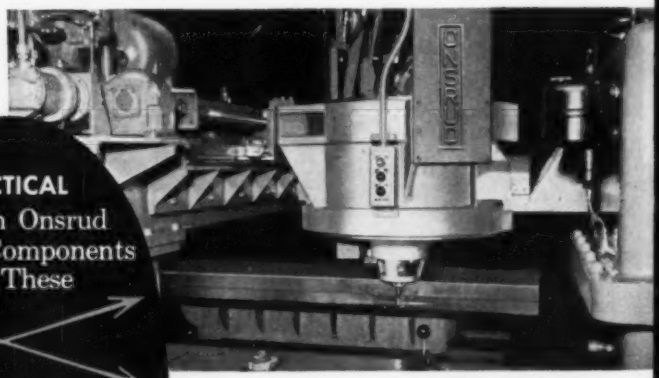


ELECTRONIC CONTROL SYSTEMS For control of speeds and feeds beyond the limits of mechanical systems and manual control . . . and extension of production milling machine application to parts impossible to machine before. Designed and built as Selsyn follower, analog and digital systems.

HIGH SPEED INDUCTION MOTORS Built in capacities from 1 to 150 HP, for spindle speeds from 3,600 to 20,000 RPM. Air or liquid cooled for greatest possible sustained and intermittent overloads.

PRACTICAL
Through Onsrud Machine Components Like These

A wide variety of components are offered to manufacturers wishing to build their own special machines . . . components that are also employed in Onsrud designed and built milling machines. Typical components include:



INVOMIL® ROTARY MILLING HEAD One of the most unusual milling head assemblies in the machine tool field. Provides infinite rotary feed of milling head through 360°. When mounted on gantry type carriage, in combination with conventional transverse and longitudinal feeds, provides infinite feed of milling head through any point on table.

HYPER-SPEED SPINDLES Specially designed and built for the high rotational speeds of Onsrud motors. Assemblies equipped with preloaded bearings for precision end milling application. Dynamically balanced for vibration-free operation.

FAMOUS ONSRUD FIRSTS

- air turbine drives
- Metered Mist lubrication systems for high speed spindles
- water and air cooled high cycle induction drive motors
- InvOmil rotary feed milling head
- rotary table feed for automatic milling

Onsrud® FOR

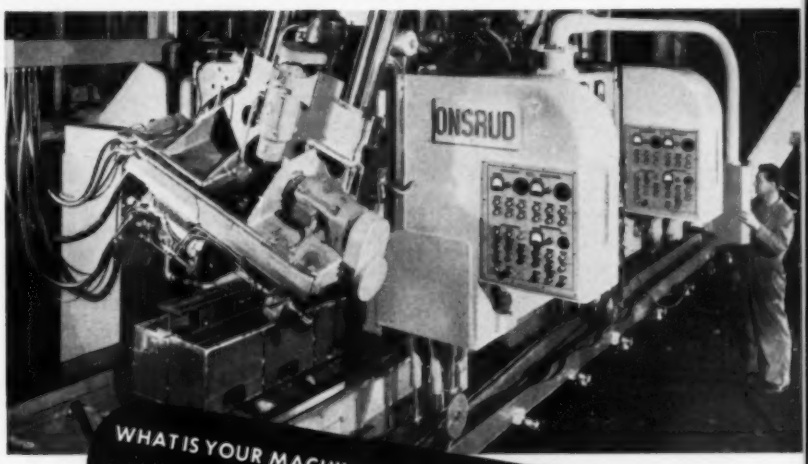
Circle 680 on Inquiry Card

leadership to serve you...

When the parts to be milled are ALUMINUM Alloys or related nonferrous metals

TYPICAL ONSRUD MACHINES NOW USED IN PRODUCTION MILLING

Onsrud A90-36 Automatic Contour or Profile Milling Machine with electronic and electro-hydraulic tracer Selsyn control system. For milling aircraft spar beams and other structural members. Reduces machine time and expands application. A precision machine for high speed automatic production.



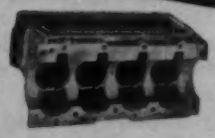
Onsrud A-242S Tri-Way Milling Machine. One vertical and two horizontal milling heads operate at one time to mill three sides of part.

Onsrud AA50-AE Rotary Feed Milling Machine, equipped with vertical head mounted on pivoted overarm. Follower on head assembly follows template as milling cutter reproduces template contour or line on work piece.

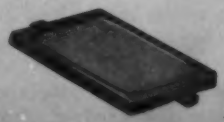
WHAT IS YOUR MACHINING TIME NOW ON PARTS LIKE THESE?

These parts are a few examples of the production time savings possible with Onsrud equipment.

Outboard Motor Housing, aluminum alloy casting, 7" wide x 13" long and 6" high. Machine three faces in one setup. Production...three complete parts per minute.

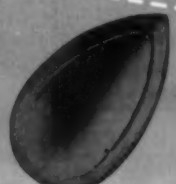


Double Section Skillet, aluminum alloy casting, 10¼" square x 3" high. Three different setups to complete parts. Production per setup... three parts per minute.



Flat Griddle, aluminum alloy casting, 11" x 11½" x 9/16" high. Machine four sides and face of top rim in one setup. Production...two parts per minute.

Aluminum alloy carburetor part. Face mill two sides... production four parts per minute.



Steam iron sole plate, aluminum alloy. Face milling operation... six parts per minute.

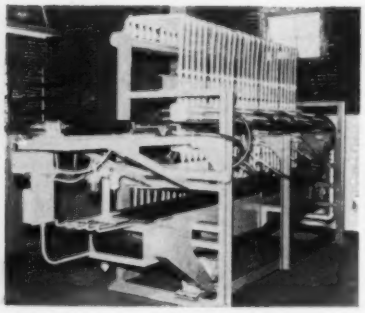
Onsrud offers components, standard machines, and machines built to your production specifications... all for the super high speed production milling of aluminum and related metals. May we invite your inquiry for complete information?

ONSRUD MACHINE WORKS, INC.
MACHINE TOOL DIVISION
7714 Lehigh Avenue
Niles 31, Illinois

DOING THINGS BETTER BY DOING THINGS DIFFERENTLY

cuit to the indicator box. The indicator unit is mounted on the gage head assembly cover. An engraved diagram panel on the front shows the outline of the workpiece and the dimensions checked. Two vertical columns of lights show the dimensions that are in error in the workpiece, either plus or minus. A central green light indicates the good components. **Pratt & Whitney Co. Inc.**, Charter Oak Blvd., W. Hartford, Conn.

—*Circle 406



Heating Machine

Item 407—

Unit is suitable for heating the centers of T-shaped heavy duty chain attachment blanks prior to making a right-angle bend. The blanks are placed on alloy rails and pushed through the heat zone by a timer actuated air cylinder which can be set to operate at any number of strokes per minute.

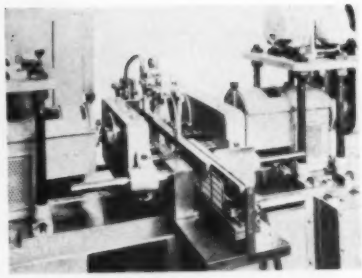
The heating zone consists of two opposing rows of high speed zig-zag burners that heat up only the center part of the blank to 1600 F required for bending. As the blanks reach the end of the heat zone, they drop to a moving metal belt chain. Blanks are returned to the operator, who places them in the press for bending. Production rate is 150 units per hour. **Gas Appliance Service Inc.**, 1940 W. Balmoral Ave., Chicago, Ill.

—*Circle 407

Tapping Machine

Item 408—

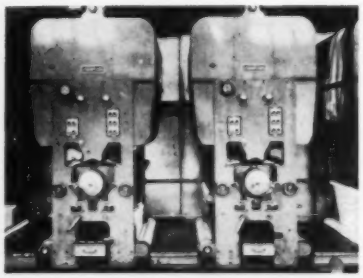
Basic two-way horizontal automatic lead screw tapping machine includes vacuum mist lubrication and disposal system. Unit is capable of tapping #6-32 holes in either



of two different types of brass terminal inserts—40 holes in one part and 20 in the other—at the rate of 720 parts per hour.

Parts of either type are hand loaded vertically into a track and pushed forward into work position by means of a hand actuated fixture. When the part is in position, two synchronized horizontal screw tapping units are actuated. As each part is fed through the two work stations, one completely tapped part, free from oil or chips, is automatically ejected into the tote box. **Ettco Tool & Machine Co. Inc.**, 594 Johnson Ave., Brooklyn 37, N. Y.

—*Circle 408



Gravure Converter Press

Item 409—

Unit capable of high speed and precise register for cellophane, paper backed foil, gift wraps, beer labels, bread or frozen food wrappers, wallpapers and paperboard.

Ink is fed from a pump through a special composition hose to the ink applicator where it is distributed by baffles in a uniform flow across the surface of the engraved cylinder. Standard overflow and pressure type applicators are available. The unit is equipped with a 15 gal portable tank with integral centrifugal pump and a secondary ink bath for high speed runs.

Controlled impression pressures are supplied by two hydraulic cylinders, and pressure is individually selected at each unit. Constant web length in the unit is maintained regardless of the impression cylinder position.

The main drive can be located between any two printing units as all unit drives are coupled to each other; a continuous drive connection the length of the press results. The gear unit consisting of a set of heavy-duty right angle worm gears is capable of 25 hp.

The converter is offered in printing widths of 44 and 54-inches. Two dryers are available for use on the converter, both equipped with steam coils, gas or electric heater and individual fan and motor. **Champlain Co. Inc.**, 88 Llewellyn Ave., Bloomfield, N. J.

—*Circle 409

Gear Deburring

Item 410—

Two-station machine chamfers and deburrs gear teeth at both ends of a groove, is designated Model BMED-14S. Each part is automatically processed through two work positions in a cycle time of six seconds at a rate of 600 parts an hour. In operation, parts are fed from a distribution system to a slide and chuted to a stop where they are checked by mechanical fingers for proper horizontal position. If misaligned, the machine automatically shuts off, flashing a red light as a visual signal. Properly oriented parts continue through the chute.

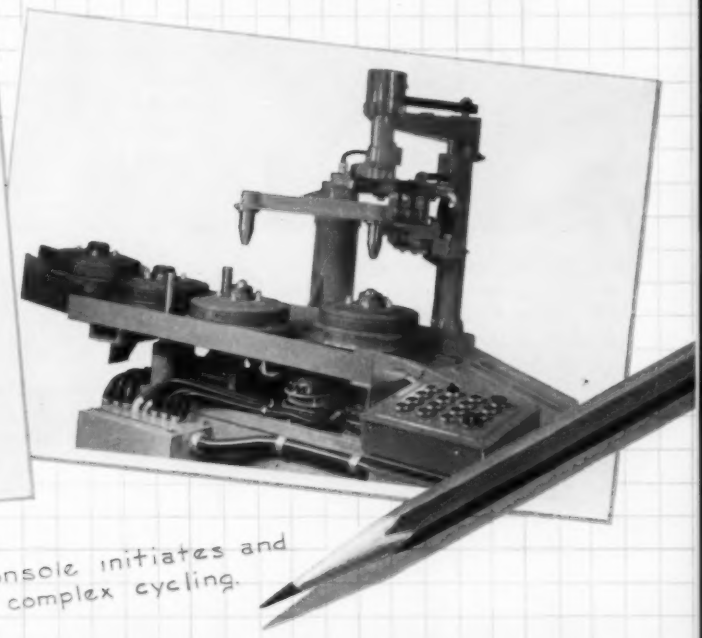
One part enters the index fixture at a time, moves to a work station and is positioned against spring-loaded bushings. As the dovetail form cutters are stroked across the part face being chamfered, a pilot gear electrically counts the number of teeth. When completed, the counter stops the machine with the cutters in a retracted position. The part is moved to the second work station where the other face of the groove is chamfered by the same method. Then the part is chute ejected.

The operational cycle of the indexing machine is: start cycle, trip limit switch to energize elec-

*For Inquiry Card, see page 17

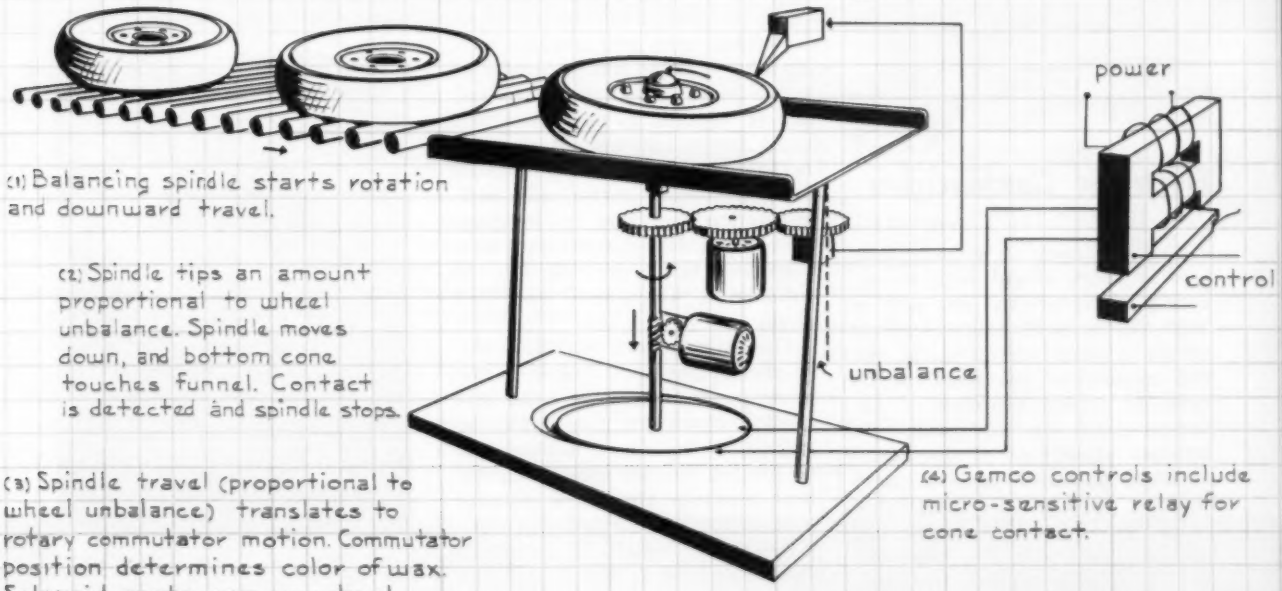
Circle 681 on Inquiry Card→

This automatic wheel balancer marks the spot where balancing lugs are needed, color codes for the proper lug.



A GEMCO console initiates and controls the complex cycling.

LOCATES & MEASURES WHEEL UNBALANCE



(1) Balancing spindle starts rotation and downward travel.

(2) Spindle tips an amount proportional to wheel unbalance. Spindle moves down, and bottom cone touches funnel. Contact is detected and spindle stops.

(3) Spindle travel (proportional to wheel unbalance) translates to rotary commutator motion. Commutator position determines color of wax. Solenoid spots wax on wheel where lug is needed

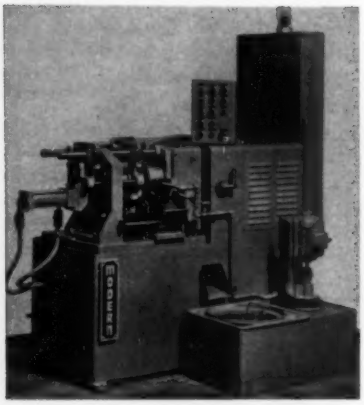
(4) Gemco controls include micro-sensitive relay for cone contact.

Whatever your control problem, it's well handled at Gemco. Write, wire or phone today.

GEMCO

CUSTOM CONTROLS

GEMCO ELECTRIC COMPANY



tric clutch and de-energize electric brake which starts chamfering action; timer counter controls number of teeth being cut; count-out which de-energizes clutch, energizes brake, and actuates a solenoid to start quill return; and quill return closes all limit switches and repeats cycle. **Modern Industrial Engineering Co.**, 14230 Birwood Ave., Detroit 38, —*Circle 410

Electronic Checkweigher

Item 411—

Unit designed to indicate correct or short weight with an accuracy of better than one part in 1000. All required weight settings within a range from ¼ to the full capacity of the scale can be made by setting the dials on the tamper-proof control panel. No internal adjustment of the mechanism is needed. A panel-mounted control provides an adjustable weight allowance to accommodate normal variation in container weight, with a variable predetermined weight tolerance of zero to 1 per cent of the applied load. An underweight-overweight indicator is included in the unit. A green light indicates correct weight, and a red light and a chime can be set up to indicate either underweight or overweight. The indicator can be externally mounted to the scale or built into the case.

An auxiliary electrical output signal from the scale is available to actuate automatic conveyor systems for rejecting short-weight packages, marking packages, or stopping the conveyor line. **Triner Scale & Mfg. Co.**, 2716 W. 21st St., Chicago 8, Ill.

—*Circle 411

Gear Checker

Item 412—

Pedestal-type gear gaging, sorting and machine tool control unit is for gear production lines. Unit can be adapted to check size and helix angle accuracy of spur or helical gears. Model GRF consists of a motorized gaging and sorting unit where gears are fed from an inclined feed chute. Gears pass inspection and travel through the machine to an inclined exit feed chute.

Gaging unit has a motorized lower master gear and a nonrotating upper master gear where the production gears are passed for the gaging check. Upper master gear is pivoted in two planes, to assure accurate size check without helix angle interference. An anti-jamming slip clutch in the drive mechanism for the lower rotating master gear automatically remeshes any gear that does not initially engage the master gears correctly. Reject pans for gears that do not pass size or helix angle specifications are under the gaging machine. Device can also be used as a feedback control unit to automatically shift hobs on hobbing machines when measurements indicate dulling of the tool. **National Broach & Machine Co.**, 5600 St. Jean Ave., Detroit 13, Mich.

—*Circle 412

Automatic Hopper

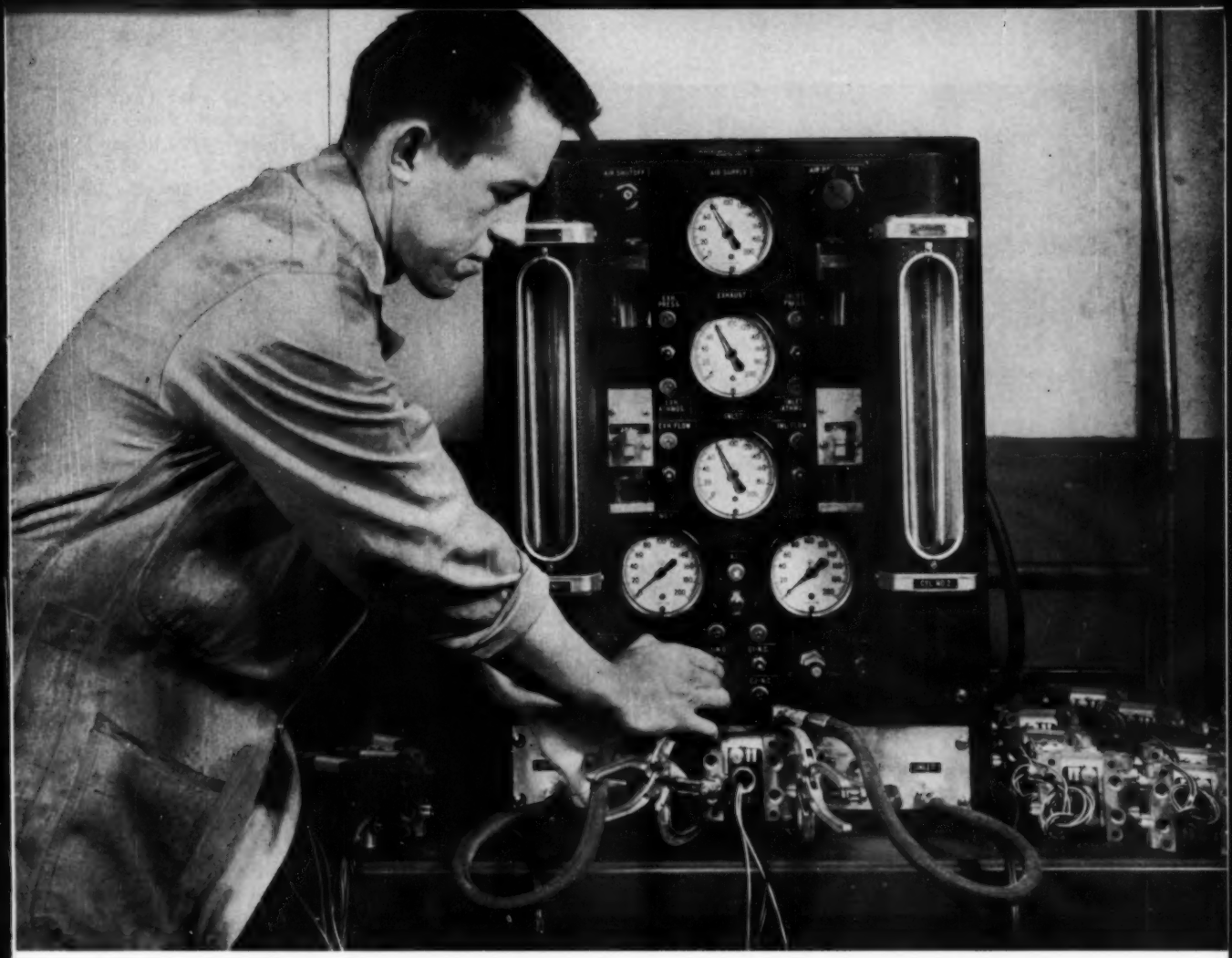
Item 413—

High speed parts-feeder and counter is suitable for nuts, bolts, screws, washers, die cast parts and screw machine parts. Depending on the size and shape of the parts being hoppered, the production rate is up to 200,000 parts per hour. As the hopper, a cast iron barrel with cast-in pockets, revolves, the items slide into the pockets. A stationary plate traps them and gradually covers more of the pocket opening as the pocket revolves up to the top position. Then the covering plate ends, allowing the parts to flow down a chute which orients them. Parts not properly oriented are rejected back into the hopper by means of a revolving wheel.

A long discharge track allows a large reserve of parts along the track and makes it possible to release a greater number of parts

simultaneously where the hopper is used for counting or packaging. Change-over from one size to another takes about five minutes and requires no extra parts. The unit uses 110v, 60 cycle ac; is

*For Inquiry Card, see page 17



The 100% testing of all Skinner Solenoid Valves is your guarantee of consistent leakproof life

Every single Skinner Solenoid Valve receives 100% leakage inspection before shipment. Each one is tested under full pressure conditions at every point for both internal and external leakage. Modern, sensitive equipment like that shown above is used to quickly detect any defect.

In laboratory tests Skinner valves are regularly getting over 20 million cycles without leakage. And these remarkable results are constantly proving out in service.

In vacuum service, for example—and in critical test equipment—standard Skinner valves are frequently specified because of their record for outstanding trouble-free performance.

So, if you are looking for solenoid valves with exceptionally long leakproof life, look to Skinner valves. For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 359.

Skinner Solenoid Valves are distributed nationally

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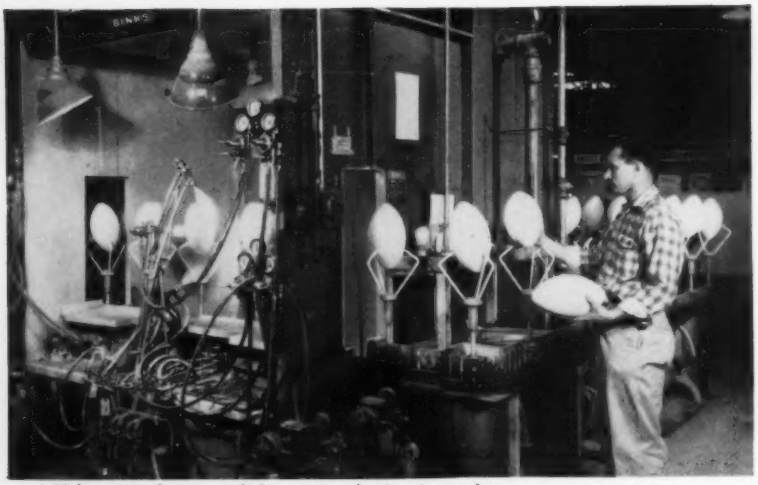
SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION

NEW BRITAIN CONNECTICUT

105 EDGEWOOD AVENUE



A Binks automatic spray painting system takes just 4 seconds to completely finish rubber coated athletic balls at A. G. Spalding & Bros., Chicopee, Mass., plant.

At Spalding...

Binks automatic finishing system cuts spray painting costs 40%

"Our Binks automatic spray painting system has helped us cut our material cost 18% and overall finishing cost 40%," reports Chester Kobak, A. G. Spalding & Bros., Rubber Department foreman.

How this system finishes up to 250 balls an hour. Vertical spindles, with special three-pronged holders, move on an endless conveyor. Balls are placed manually on each holder. As the spindle approaches the spray guns it rotates rapidly, exposing all surfaces of the product. Three Binks Model 21 spray guns automatically apply a uniform coating to all exposed surfaces. The guns operate only when a ball passes in front of them, making maximum use of the coating materials. After spraying, the balls complete the conveyorized circuit, air-drying en route.

Improved working conditions. The Binks Dynaprecipitor water wash spray booth safely removes all overspray and keeps shop air fresh and clean. It exceeds the requirements of fire, health and state authorities.

Minimum maintenance. The spray booth's water wash feature so completely removes paint pigment from the overspray that exhaust fans, stacks and booth surfaces require a minimum of cleaning.

Engineering assistance available to you. Binks finishing engineers worked closely with Spalding to solve their finishing problem. This same assistance is available to you, without obligation. Just contact your nearest Binks Branch Office or write direct to the address below.

Ask about our spray painting school
Open to all...NO TUITION...covers all phases

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EVERYTHING FOR
SPRAY PAINTING

SPRAY GUNS

MATERIAL HANDLING PUMPS

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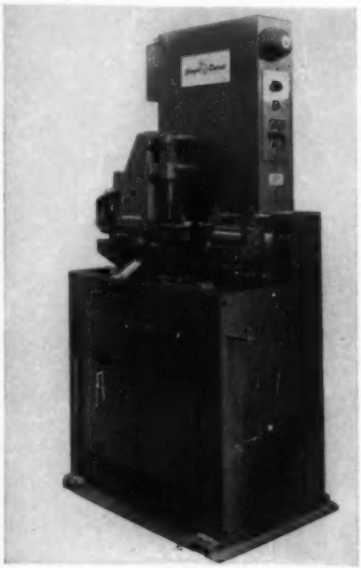
Circle 683 on Inquiry Card

driven by a 1/5 hp gear headed motor. The knock-off wheel is driven by a separate 1/70 hp motor. **U. S. Engineering Co.**, 40-24 22nd St., Long Island City, N. Y. —*Circle 413



Ram Test Unit

Item 414—

Device developed to automatically test the strength of a brazed joint in automotive valve lifters. Production rate is 1800 per hour. Machine applies 3000 lb load so the end of the lifter foot will not break away from the cylindrical body. Faulty parts are automatically rejected. **Cargill Detroit Corp.**, Birmingham, Mich.

—*Circle 414

Extrusion Press

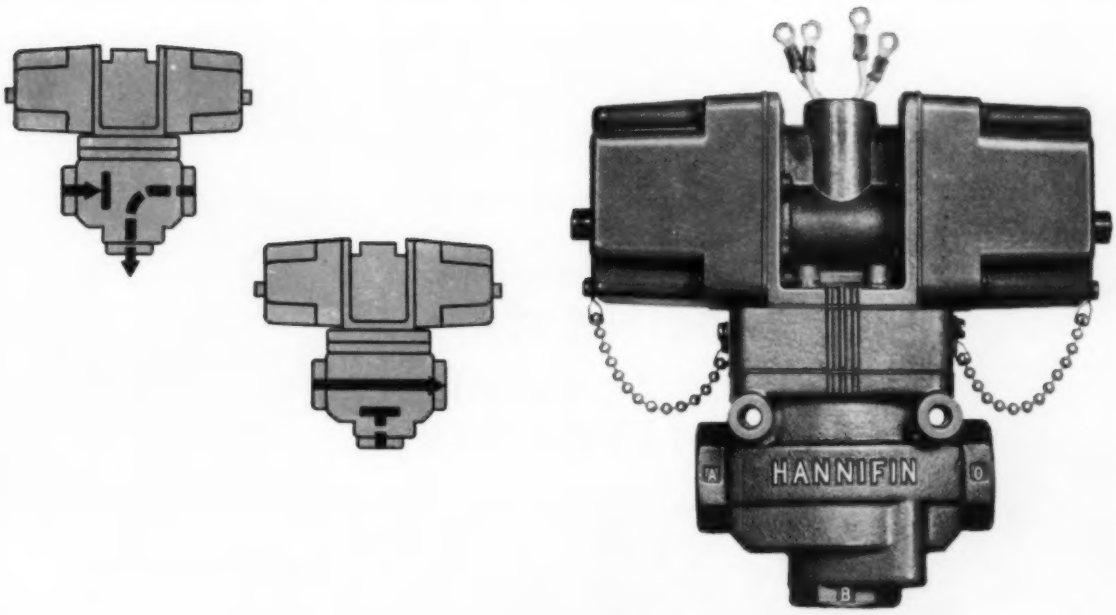
Item 415—

Oil hydraulic machine capable of extruding a broad range of aluminum sections and tubing of round, rectangular and irregular shapes. Four variable-delivery radial piston pumps direct optimum quantities of oil to the press components, and fixed and variable position limit switches assure precise sequence operation. The result is a rapid, fully integrated operation of all press components, providing minimum dead cycle

*For Inquiry Card, see page 17

Setting the pace for automation

...Hannifin valves



Automatic processes call for speed, sensitivity and flexibility in directional air control. Above all, they demand dependability. That is why so many valve users find it pays to choose Hannifin.

Every feature that contributes to dependable performance has been incorporated in Hannifin air control valves. This dependability is the result of never-ending research and development.

In the broad Hannifin line, you will find valves with new exclusive features... valves for practically any kind of automatic sequential operation. All are simple in design, with few and easily replaceable parts.

AIR CONTROL

HANNIFIN

VALVES

For this complete catalog showing all the Hannifin directional air control valves, write to Hannifin Corporation, 541 South Wolf Road, Des Plaines, Illinois

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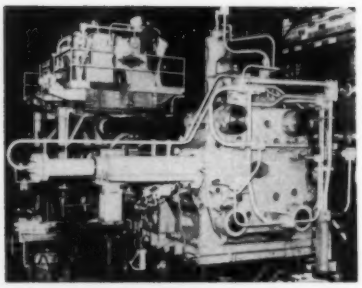


time and maximum utilization of the press for actual extrusion.

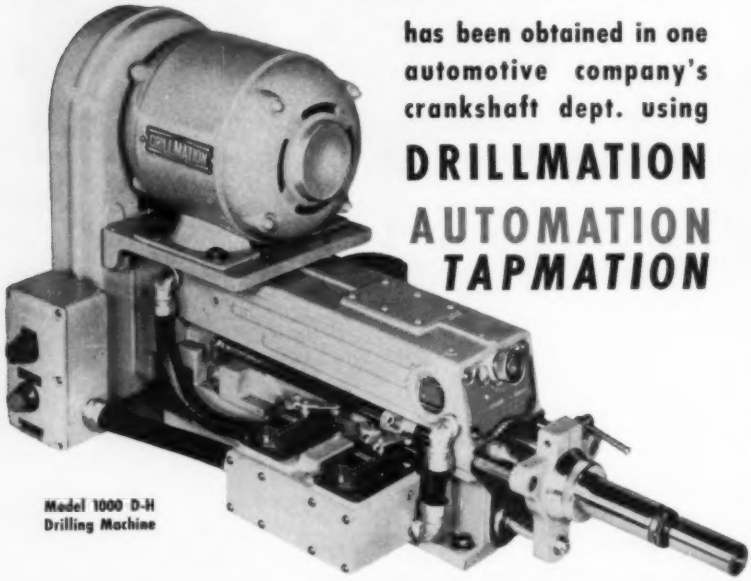
Complete flexibility is offered under varying conditions of extrusion by the variable delivery pumps and pushbutton controls. The press controls are interlocked to provide fully automatic sequence cycling and prevent non-sequential operation.

If required, the press can be jogged through one operation at a time, by separate controls. Extrusion speed ranging from zero to 42-inches per minute can be regulated from the main pulpit or from a location overlooking the emerging extrusion. This dual control is electronically signalled and operated by an indicator hand lever. A die slide arrangement provides an alternate die location for inserting, removing, dressing or adjusting a second die while extrusion continues uninterrupted on the first die. A third position allows rapid ejection of unextrudable billets. **Birdsboro Steel Foundry & Machine Co.**, Birdsboro, Pa. —*Circle 415

300% Greater Tool Life

has been obtained in one automotive company's crankshaft dept. using

DRILLMATION AUTOMATION TAPMATION



Model 1000 D-H Drilling Machine

12 NECESSARY, *Exclusive* FEATURES IN 1 UNIT

- **DULL TOOL CONTROL** Unit will withdraw tool from work and indicate to operator when tool becomes dull.
- **RAPID TOOL CHANGE** Tool may be replaced without changing the controls.
- **UNIFORM TIME CYCLE** Maintains comparatively constant time cycle even when tools become dull.
- **SELF-CONTAINED HYDRAULIC SYSTEM** Delivers only the oil pressure required to overcome machining resistance.
- **COMPLETELY AUTOMATIC** Enclosed electric controls. Unit is "Fail Safe".
- **THRUST CONTROL** Maximum thrust may be set to protect tools. Will not surge at break point.
- **FEED CONTROL** Infinitely variable and positive feed rate.
- **RAPID APPROACH AND RETURN** Variable irrespective of RPM.
- **MICRO DEPTH CONTROL** Depth will repeat within .0005 inch.
- **EMERGENCY QUILL RETURN** Button on front of unit. Aid in setting tools.
- **COOL OPERATION** Low volume high pressure hydraulic pump used on power stroke only. Air power used for rapid traverse.
- **PRODUCTION MACHINE** Mount in any position. Quiet operation. Self lubricating.

DRILLMATION

"FOR THE HOLE FIELD"

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6500 E. ELEVEN MILE ROAD
CENTER LINE, MICHIGAN
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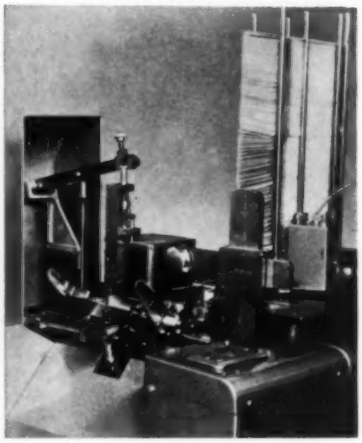


Glue Attachments

Item 416—

Useful for applications where cartons are mailed without over wrapping, glue attachments provide tamper-proof packaging by sealing the carton tuck. The attachments can be installed on company's automatic cartoning machines. For carton sealing at both ends, an attachment for the closing unit is available. **Bivans Corp.**, 2431 Dallas St., Los Angeles, Calif.

—*Circle 416

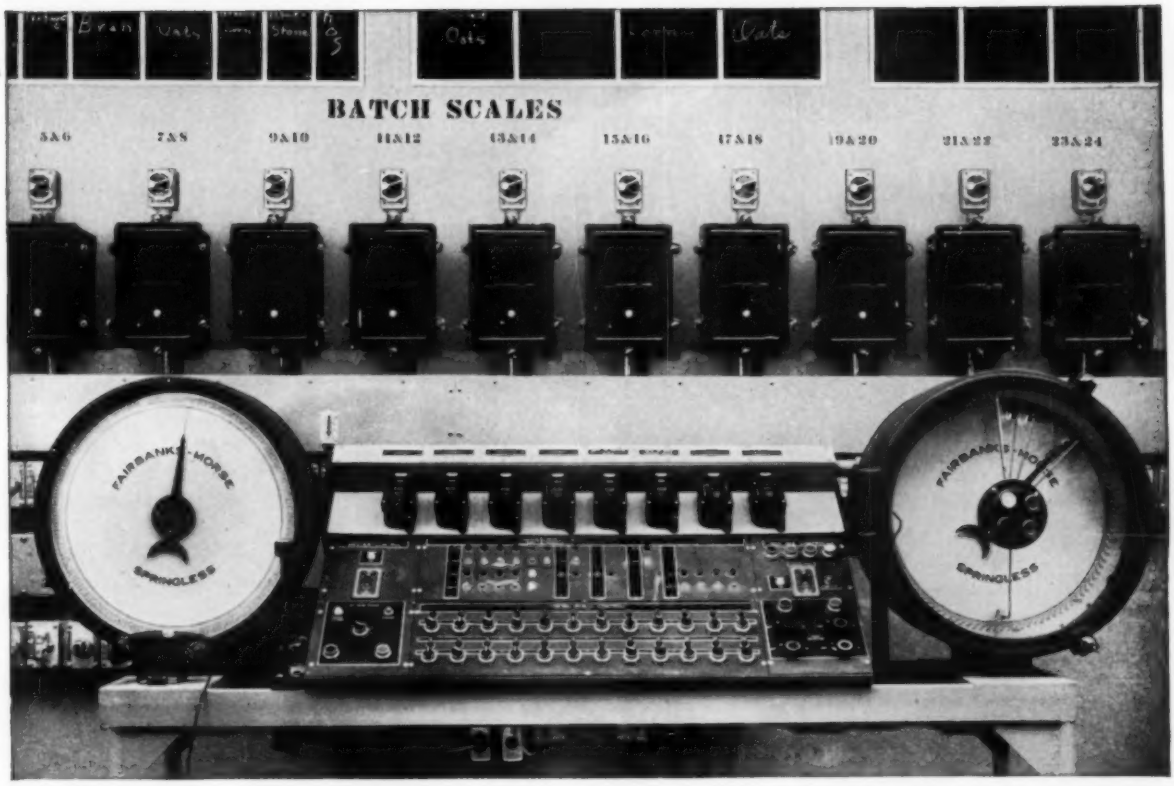
Bottle Conveyor

Item 417—

Unit delivers bottles, jars or cans to single or multiple-liquid fillers. The conveyor can be mounted on the front of base-mounted fillers or attached (shown) to a roller stand for use with bench type fillers. The conveyor chain is driven by sprockets on 6 ft centers, powered by a

*For Inquiry Card, see page 17

Twenty-six in one



There are 26 separate scales answering to the switches on the control unit of this Fairbanks-Morse electromechanical batcher installed at the Farmers' Elevator Service Company of Fort Dodge, Iowa, by contractor Hogenson Construction Company of Minneapolis.

Twenty-four of the Fairbanks-Morse hopper scales deliver preestablished quantities from their respective bins according to standard formulas set up on their individual beam indicators. The right dial controls the weighing of expensive additives — molasses, for instance. Presetting is done right on the dial, and can be varied from batch to batch. The left dial is a remote indicator used to check the final weight of the complete batch before it is dumped into the mixer.

Fairbanks-Morse builds mechanical and electronic batchers as well as this electromechanical batcher designed for the specific conditions at Farmers' Elevator Service. Whatever your batching requirements, Fairbanks-Morse will design and build to give you the traditionally accurate Fairbanks-Morse performance with a new measure of speed, economy—and profit.

Fairbanks, Morse & Co., Dept. A-9 — 600 South Michigan Ave., Chicago 5, Illinois.

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a name worth remembering when you want the BEST

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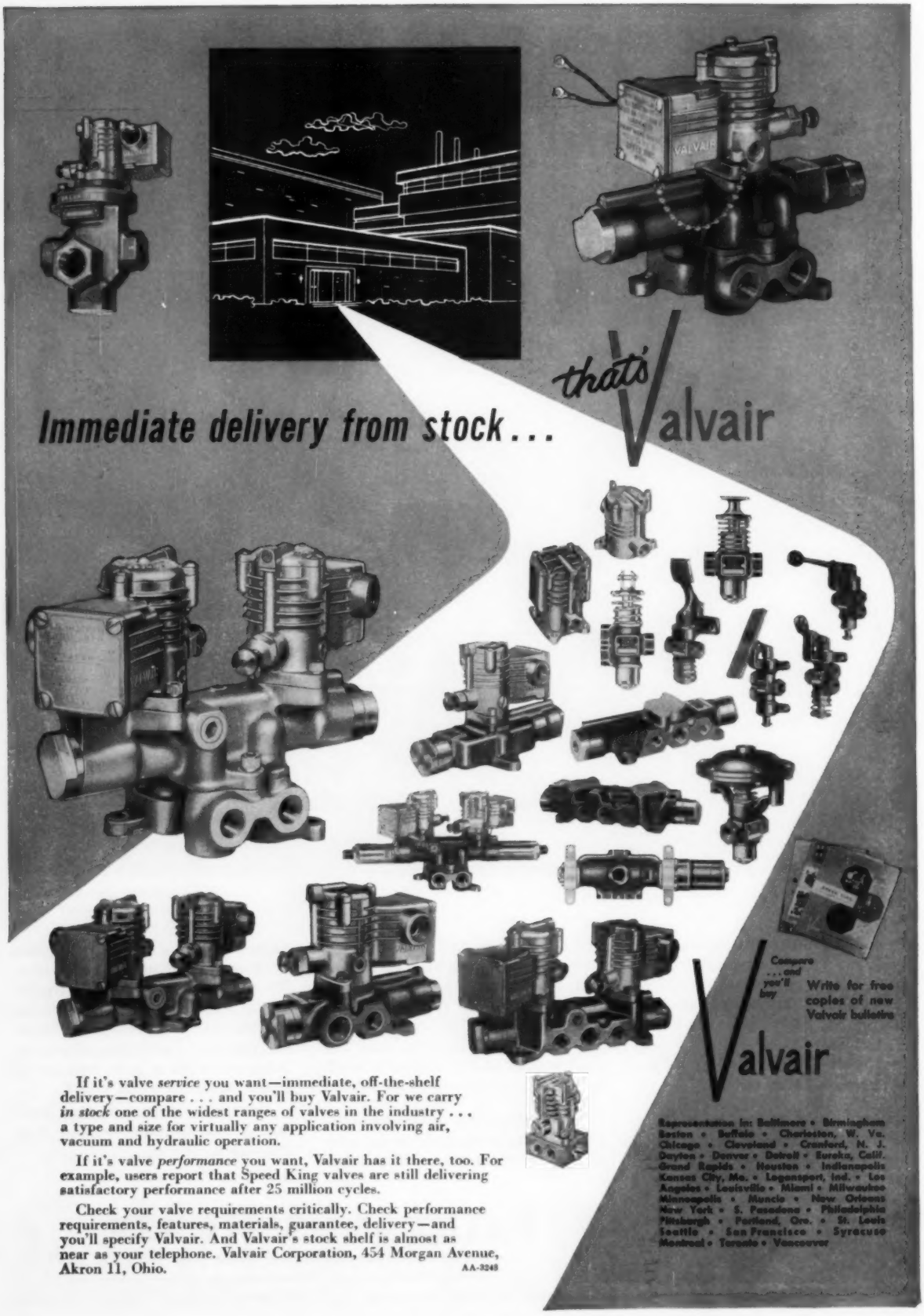

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If it's valve *performance* you want, Valvair has it there, too. For example, users report that Speed King valves are still delivering satisfactory performance after 25 million cycles.

Check your valve requirements critically. Check performance requirements, features, materials, guarantee, delivery—and you'll specify Valvair. And Valvair's stock shelf is almost as near as your telephone. Valvair Corporation, 454 Morgan Avenue, Akron 11, Ohio.

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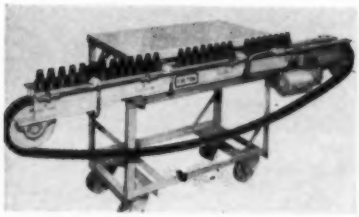
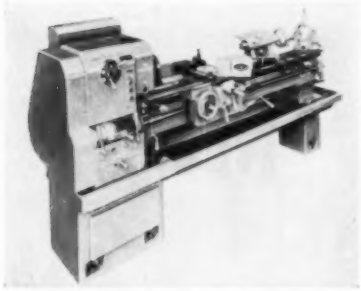


1/6 hp, right-angle gear motor equipped with a starter switch. Conveyor speeds are adjustable up to 80 fpm by changing the sprockets.

For multiple filling, a three air cylinder escapement attachment, controlled by a solenoid operated master valve is available. A factory air line pressure of 25 psi operates the escapement. Timing is provided by contact between any moving machine part that operates once during the filling cycle, and the button type air valve leading from the escapement unit. **Arthur Colton Co., Div. of Snider Tool & Engineering Co.,** 3400 E. Lafayette Ave., Detroit 7, Mich.
—*Circle 417



Automatic Tracer Lathe

Item 418—

Automatic turning of multiple diameter shafts and contoured workpieces, retaining the versatility of a standard lathe, is provided by design of tracer lathe. A single pushbutton starts the operation. The entire Hydraguide tracer mechanism is mounted on the carriage with all controls, template, tracer finger and tools on the operating side of the lathe. The swiveling tracer is normally set at a 45 degree angle to the center line of the lathe, allowing the machining of square shoulders at high feed rates without interruption of lateral carriage movement. Models are built in 15 and 18-inch swing sizes in a variety of center distances from 30 to 114 inches. **Cincinnati Lathe & Tool Co.,** Cincinnati 9, Ohio.
—*Circle 418

Turning & Boring Unit

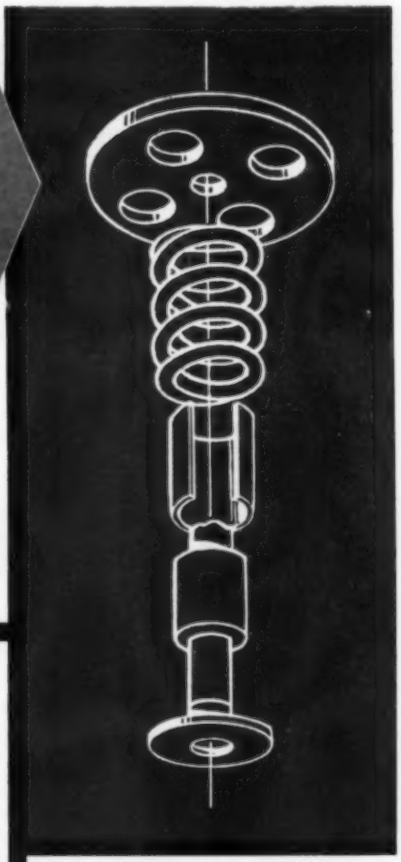
Item 419—

Machine is capable of turning, boring, facing, forming, grooving, chamfering, beveling and cutting-off. Model 6405 Hydra-Cycle has a hydraulically operated cross slide mounted on a hydraulically operated longitudinal table. Four cycles are available on control panel. Block tool holders, carbide insert bits and standard boring bars can handle most jobs. The operator loads the machine, pushes one button and unloads; the rest of the operation is automatic.

Electrical controls are located at top of headstock. Toggle switch on control panel can be set so spindle stops automatically at end

*For Inquiry Card, see page 17

GRAY Automated EQUIPMENT Gives Six Times Faster Assembly Per Worker



At Comparably Lower Cost
Of Uniform Quality
In 50% Less Space
With 83% Labor Savings
Paid for Itself in 4 Months

This five-part valve insert is assembled, fastened, counted and marked at the rate of 1800 per hour in an eight-station assembly machine designed and built by Gray Equipment Co.

Is Automation Best for You?—Gray engineers will evaluate your problem objectively.

Complete Service From One Source—Our broad knowledge of the many factors affecting automation enables us to handle every phase from project analysis through equipment construction to machine tryout.

For recommendations, send work samples and requirements. Ask for our brochure, "Automated Assembly."

- Automatic Dial Fed Assembly Machines
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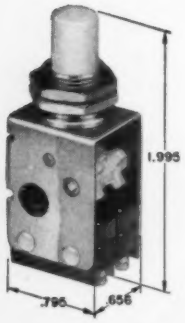
Designed to meet modern electrical control requirements

MICRO SWITCH pioneered the development of precision switches... It has been first in precision switching for two decades... These new switches are typical of MICRO SWITCH's continuing leadership.



NEW!

MICRO SWITCH alternate action pushbutton switch gives on-off control of up to four circuits

Shown here is the MICRO SWITCH 82PB1-T2 (unlighted) which allows on-off control of up to four circuits. When the switch button is pushed, the contacts of the switches are alternately reversed. They complete a cycle of action every two operations of the button.

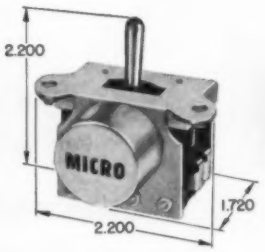
This alternate action is achieved by the extremely compact design of a long-life assembly of ratchets. Variations are possible which will permit almost any sequence of switch operation. For instance, on a switch with a four-push sequence, a great many sequences of switch operation can be provided.

This switch requires but 1¾ in. below its mounting panel and mounts in a ½ in. hole. Button is of off-white plastic. Operating force is 35 oz. max.

(Send for Data Sheet 124)

SWITCH CHARACTERISTICS

Two SPDT switches; break distance .010 in. min. Electrical data: U/L listed at 5 amps. 125 or 250 vac; 30 vdc rating: inductive, 3 amps. at sea level and 2.5 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet. Maximum inrush is 15 amps.



NEW!

MICRO SWITCH magnetic hold-in toggle switch—permits remote release of toggle lever to its unoperated position

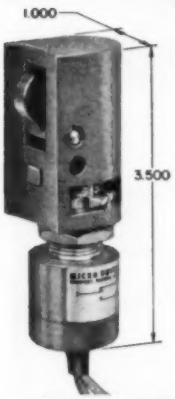
This MICRO SWITCH 2ET1 magnetic hold-in toggle switch is a momentary-action toggle switch which also functions as a maintained-contact switch by means of a solenoid incorporated into the design of the switch. When the toggle lever is operated and the solenoid is energized, the magnetic force of the solenoid holds the switch in the operated position. This magnetic hold-in feature permits remote electrical release of the lever.

The precision SPDT switch and a 28 vdc solenoid are contained in one compact unit. The small size makes it an ideal component for applications where space is a critical factor. *(Send for Data Sheet 137)*

SWITCH CHARACTERISTICS

Total travel 30°; Electrical data: 28 vdc rating: inductive 3 amps. at sea level and 2.5 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; motor, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet; Hold-in rating of solenoid is 18-30 vdc.

Switches have uses unlimited



NEW!

MICRO SWITCH "Rocket Switch"— a rugged, sealed small switch for indicating and lockout devices

Developed for use on rocket launchers, this MICRO SWITCH 21AS2 assembly fits the needs of many industrial designs.

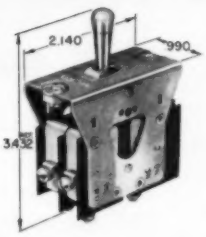
The assembly consists of one SPDT Type-EN switch attached to a rugged cam-type actuator. The assembly is environment-proof and withstands the highly-corrosive effects of rocket propulsion gases. The assembly will withstand heavy impact hammer blows on the actuator.

(Send for Data Sheet 120)

SWITCH CHARACTERISTICS

Operating force—6 to 12 lbs. Full overtravel force—10 lbs. min.; Release force—4 lbs. min.

Electrical Data: 28 vdc rating: inductive, 3 amps. at sea level and 2 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet. Motor, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet. (Altitude ratings established with seal deliberately broken.)



NEW!

MICRO SWITCH three-position toggle switch—4 SPDT circuits with a single lever

MICRO SWITCH 115AT Series of toggle switches uses four SPDT switching units. Two units are actuated in each extreme toggle lever position. None are actuated when lever is in center position.

Many different combinations, however, may be obtained, including the make and break of circuits in all three lever positions.

Outstanding features of this series include the compact design, positively-driven switch actuators and sturdy construction. A safety catch guards against accidental movement of toggle lever. *(Send for Data Sheet 132)*

SWITCH CHARACTERISTICS

Electrical rating at 30 vdc: inductive—10 amps. at sea level, 6 amps. at 50,000 ft.; resistive—10 amps.; motor—6 amps. Basic units listed by Underwriters' Laboratories for: 10 amps. 125 or 250 vac; ½ amp. 125 vdc; ¼ amp. 250 vdc.

NEW!

MICRO SWITCH completely sealed magnetic hold-in toggle switch

The MICRO SWITCH 5ET Series is a completely sealed momentary action toggle switch which also functions as a maintained contact switch. When the toggle lever is operated and a solenoid is energized, the magnetic force holds the lever operated. This hold-in feature permits remote electrical release of the lever.

Both switch and solenoid are sealed within the cylindrically shaped enclosure. This insures constant operating characteristics. An elastomer seal at the base of the toggle lever prevents entrance of dust or moisture. *(Send for Data Sheet 121)*

SWITCH CHARACTERISTICS

Total travel 30°; Contact arrangement SPDT, may be wired either N. O. or N. C. Electrical rating at 28 vdc: inductive, 3 amps. at sea level and 2.5 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; motor, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet; Hold-in rating of solenoid is 18-30 volts dc.

NEW!

MICRO SWITCH "typewriter" pushbutton switch for manual keyboard control

MICRO SWITCH 1PB81-T2 switch is ideal for one-finger rapid-repeat operation such as is required for the type of keyboard control found in electric typewriters, adding machines, etc. The repeat action is as rapid as the fastest operator can push the button.

This switch uses a SPDT MICRO SWITCH subminiature switch for snap-action reliability. The contoured button and unique overtravel spring combine to reduce operator fatigue. Operating "feel," however, is sufficient to avoid mistakes and false actuations.

Removable ½ in. dia. plastic button is available in red, green, off-white or black. It is keyed to prevent rotation. *(Send for Data Sheet 125)*

SWITCH CHARACTERISTICS

Electrical rating at 30 vdc: inductive—3 amps. at sea level and 50,000 ft.; maximum inrush—15 amps. Basic subminiature switch is listed by Underwriters' Laboratories at 5 amps. 125 or 250 vac.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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FOR AUTOMATED ASSEMBLY LINES THE
SEMI-AUTOMATIC
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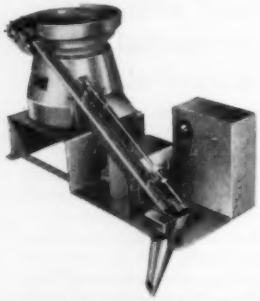
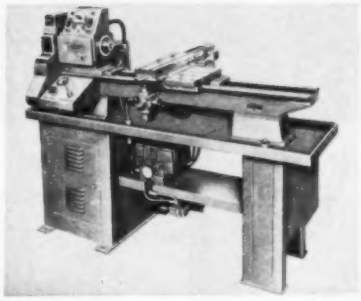
hardware items into conveyor belts or pre-formed containers.



BFM
AUTOMATIC POWDER, LIQUID AND HARDWARE PACKETING MACHINERY
BROWN
FILLING MACHINE COMPANY, INC.
Division of FRANKLIN RESEARCH CORPORATION
FITCHBURG, MASS.

Circle 690 on Inquiry Card



of cycle or continues running. Switches are interlocked so spindle and cycle cannot operate unless pump is running; pilot lights indicate when pump is operating and machine cycling. **Clausing Div., Atlas Press Co.,** 2100 N. Pitcher St., Kalamazoo, Mich.

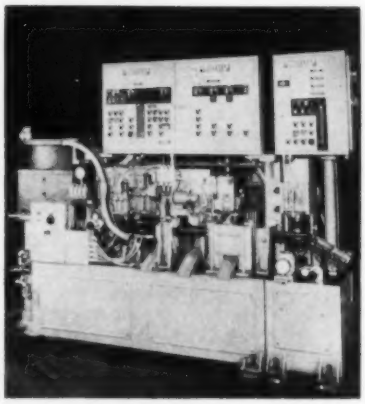
—*Circle 419

Coil Stock Straightener

Item 420—

Increased speed range and adaptability to automatic feeding are features of the 308 series coil stock straightening machines, now available with Warner Electric Clutch-Brake assembly attached to the lower pinch roll shaft. Equipped with an electric clutch-brake, the unit supplies straightened stock 0.018 to 0.065-inch thick and 1 to 8-inches wide at speeds of 20 to 120 fpm through a 6 to 1 variable speed drive. Arm-controlled engaging and disengaging action of the clutch allows instant full speed starts and controlled stops. The straighteners serve as automatic feeding units, supplying stock to a punch press or shear using a die with a positive stop. **F. J. Littell Machine Co.,** 4127 N. Ravenswood Ave., Chicago 13, Ill.

—*Circle 420



Gaging Unit

Item 421—

Taper roller bearing assembly machine that automatically gages the diameter and flange thickness of the inner race, selects the proper number of rolls from one of six preselected size hoppers and automatically assembles race, rollers and cage into a bearing of predetermined tolerance. The bearing is checked for torque, standout and noise level and separated as acceptable or reject.

Also offered in the line of gaging and assembly machines is the Checkmatic, with an inspection rate of 1200 parts per hour. Equipped with adjustable tooling, the unit covers a wide range of bearing sizes and automatically segregates, selects and rejects on the basis of radial play measurement. **Sheffield Corp.,** Dayton 1, Ohio.

—*Circle 421

Press Feed Equipment

Item 422—

Unit designed to automatically straighten, measure and cut coil stocks of aluminum to desired blank sizes. Machine consists of a motorized coil reel with loop control arm, press feed straightening and measuring unit and a high speed shear. A panel for central-

*For Inquiry Card, see page 17

AUTOMATION

IN HARDBOARD PRODUCTION

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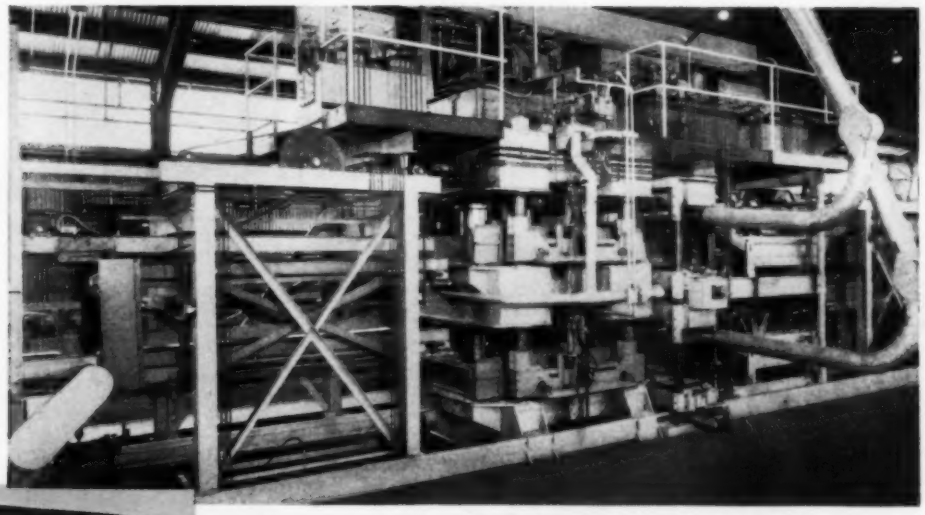
METALWORKING is not alone in using Vickers Hydraulics for Automation

REDUCES COSTS • IMPROVES UNIFORMITY • PROVIDES FLEXIBILITY

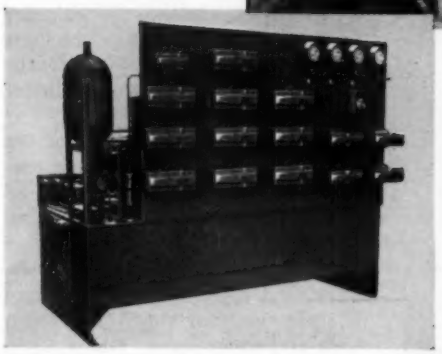


Prepress area of automatic hardboard plant designed and built as a package unit by the Industrial Development Company, Tacoma, Washington for Columbia Hardboard Company, Inc.

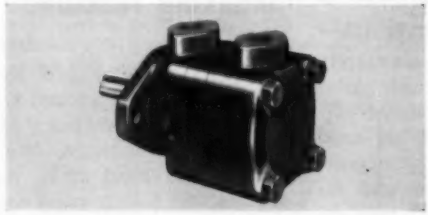
Reported to be the most highly automated in the wood products industry, this plant produces 60,000 sq ft of "Cedawood" per day (½" basis).

Seven Vickers Custom-Built Hydraulic Power Units play an important part in this performance; four are shown (in the photograph above) mounted on the platform directly above the prepress. The other three operate a series of automatic transfer systems in various parts of the plant. The transfer drives also use Vickers Vane Type Hydraulic Motors, which provide easily controlled variable speed for synchronizing various operations and for overload protection.

The use of hydraulic variable speed drives makes it easy to vary production rate, flakeboard thickness (⅛" to 1"), and type of product. Additional features are: accurate control, simplicity of installation, and low maintenance. For further information about the many benefits you get from Vickers Hydraulics, ask for Bulletin 55-67.



This Vickers Custom-Built Power Unit is individually designed to meet specific needs. It assures dependable performance, improves and simplifies design, reduces installation time and cost, and makes servicing easier. Write for Bulletin 52-45.



The performance-proven Vickers Balanced Vane Type Hydraulic Motor is an economical, efficient, and compact means of providing variable speed rotary power. It can be used for reversing service and can be stalled under load without damage. Write for Bulletin I&M-5103.

7834R

VICKERS INCORPORATED
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Machinery Hydraulics Division

ADMINISTRATIVE and ENGINEERING CENTER
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Circle 692 on Inquiry Card

ized control of all machines is included.

In operation, the stock payed off the coil is fed into the press feed unit, where it is straightened and accurately surface measured. The surface measuring is done by mechanical means and converted into electrical units. The units are sent to the central control panel into a Berkeley - Dahlstrom electronic measuring controller. Here the desired length is pre-selected. The material from the press feed unit is fed into the high speed shear and when the desired length is reached, the stock is stopped and severed by the shear. **Dahlstrom Machine Works Inc.,** 4227 W. Belmont Ave., Chicago 41, Ill.

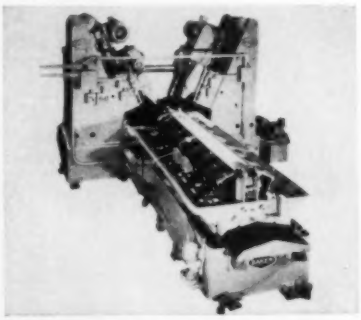
—*Circle 422

Net Weighing Machine

Item 423—

Device is capable of accurately weigh feeding a nylon resin material in 25 lb quantities. Model 447-22-NW-1500 consists of an even balance industrial scale, air operated slide valve, controller and remote control station, and was designed for use in restricted overhead clearance areas. Seven-second cycle consists of 5 seconds weighing and 2 seconds dumping. The slide valve can be mounted on a storage hopper. A dust seal designed to raise and seal the valve when the supply hopper is being filled is operated by an air cylinder mounted on the front of the slide valve. A visual indicator and dial are used with even balance lever system. Machine can be stopped on any load to visually check the accuracy. **Exact Weight Scale Co.,** 944 W. 5th Ave., Columbus, Ohio.

—*Circle 423



Cylinder Block Machine

Item 424—

Device automatically rough and finish bores and spot faces welded diesel engine cylinder blocks prior to insertion of sleeves. The part automatically indexes on the shuttle table, and the cylinder block is hand clamped.

Boring and counterboring of the cylinder sleeve holes are preformed by two basic slides with 50 hp worm gear drive boxes. Two basic slides with 5 hp bevel gear drive boxes drill dowel pin holes. Carbide tipped single point tool bits are used for rough and finish bore and counterbore. **Baker Bros. Inc.,** Toledo 10, Ohio

—*Circle 424

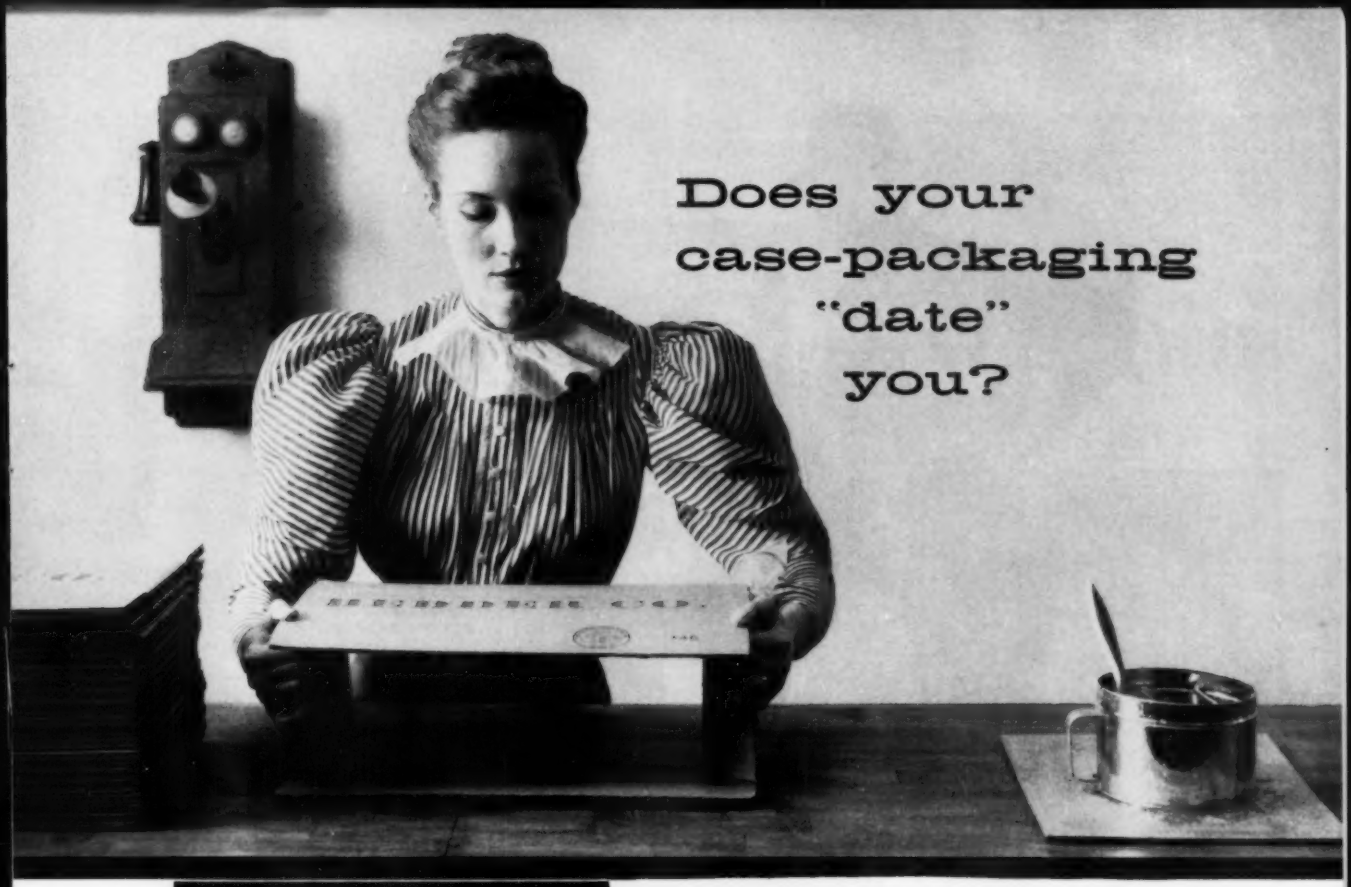
Indexing Machine

Item 425—

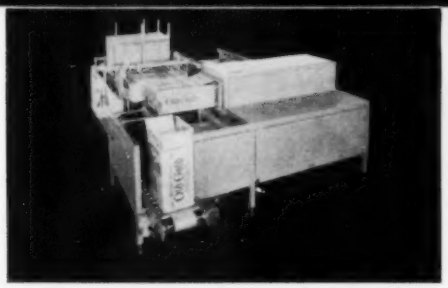
Special machine built by Hoefer Mfg. Co. is built around two Hartford Special Machinery Co. automatic drill units. A two spindle offset drill head drills, spotfaces, reams and hollow mills a group of bosses, two at a time, in a horizontal plane. After the lower level of bosses is completed, the unit

*For Inquiry Card, see page 17

Circle 693 on Inquiry Card→



Does your case-packaging "date" you?



FEEDER-FORMER-POSITIONER-LOADER-UPENDER

This machine in operation at the P. Lorillard Co. automatically end-loads regular and kingsize cartons of Old Golds at the rate of 400 cartons per minute (60 cartons per case in a 2x5x6 pattern) or nearly 5 million smokes an hour. A high-speed machine which forms cases, positions and loads fully-automatically can be the answer to your packaging line. Write us for consultation or for additional information and prices.

J. L. FERGUSON CO. Joliet 2, Ill.

New York, Chicago, Cleveland, Boston, Tampa, Baltimore, Portland, Denver, Los Angeles, San Francisco, Seattle, New Orleans, Louisville, Kansas City and All Principal Canadian Cities.

PACKOMATIC machines include the Bale Sealer — Case Sealers — Opener-Loaders — Case Imprinters — Telescoping Volumetric Filler — Packer-Gluers. Units available, semi-automatic or fully-automatic depending on your needs.

Packomatic

T.M. Reg. U. S. Pat. Off.

equipment feeds, forms, positions, loads, seals, and imprints shipping containers automatically

From the time the magazine is stacked with "knocked-down" containers until they are loaded, sealed and imprinted, ready for shipment—not a human hand is required. Here's automatic, foolproof equipment Custom-Engineered to do the whole job—or any part of it for less—and at a speed to match any production line. End-loading techniques save up to 28% on paper board costs alone. Labor savings are obvious. And, Packomatic Custom-Engineered equipment can do the trick for virtually any product; witness the case loading patterns below. Whatever your requirements, whatever your budget, there's a Packomatic machine to cut costs and boost production in your plant.

Six 5-qt. cans or gallon cans in 20⅞" x 13⅝" x 9 13/16" case and 20¼" x 13¾" x 8¼" case

Twelve 46 oz. cans in 21" x 13" x 7⅛" case

Twenty-four cartons in 12½" x 10⅜" x 8½" case

Eighteen 7 & 8 oz. cartons in 20" x 14⅞" x 8⅝" case

Sixty cigarette cartons King Size: 17⅞" x 11½" x 22" Regular: 14 13/16" x 11½" x 22"

TYPICAL CASE LOADING PATTERNS FOR CANS AND CARTONS

Twenty-four 12 oz. cans in 16⅜" x 10 15/16" x 5 5/16" case

Six No. 10 cans in 22 1/16" x 17⅜" x 7⅛" case

Thirty 1 lb. cartons in 16⅛" x 10 1/16" x 7¼" case

Twenty-four cartons in 19½" x 10⅞" x 7" case

Forty-eight cartons in 22¾" x 23½" x 15⅞" case

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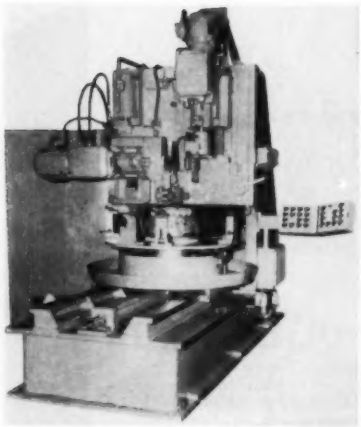


automatically raises for the insertion of a spacer, lowers again, lining up with the upper level of bosses, for the completion of the operation.

The operations are done in three passes. The first pass: drill and spotface, followed by a tool change. Then the cycle is repeated for the reaming operation, the tools changed and the cycle repeated for the hollow milling operation. Controls grouped at the nose of the drill unit permit quick setting of rapid approach, length of feed to positive depth, and feed rate to suit the three varied operations performed by this equipment.

One additional cycle is made with the vertical unit drilling two 0.078 cross holes through the bosses at right angles to the horizontally drilled holes. The work table is then moved forward for the removal of the piece, leaving the machine ready for a new piece. **Hartford Special Machinery Co.**, Hartford, Conn.

—*Circle 425

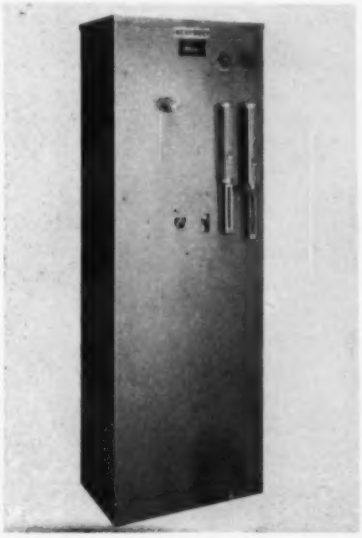
Belt Conveyor

Item 426—

Unit is suitable for unloading, transferring, boosting and stacking operations. Portable belt conveyor is hydraulically adjustable by finger-touch to optimum height and angle of incline to suit various materials handling needs. In the raised position, the conveyor provides a high-low transfer for loading and unloading freight cars or taking bags and boxes away from sealers. In the low-level position, it acts as a low cost power component in wheel and roller conveyor lines.

Six sizes are offered and all units operate in forward and reverse. On conveyors from 10 to 16 ft, the unit has a ½ hp motor, from 18 to 20 ft, a ¾ hp motor. Belt speed is 55 fpm. **E. W. Buschman Co.**, Clifton & Spring Grove Aves., Cincinnati 32, Ohio.

—*Circle 426



Automatic Gas Converter

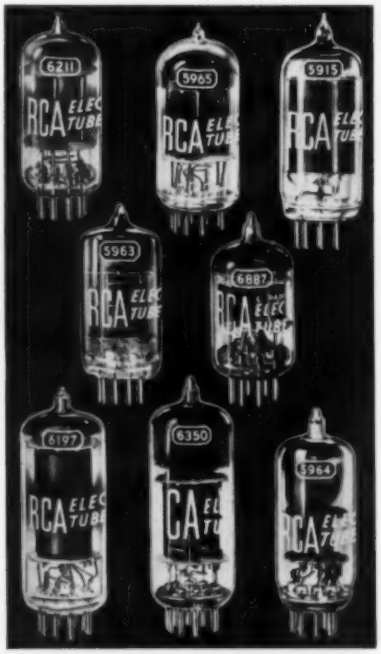
Item 427—

Unit is equipped with an automatic ignition for simple, quick starting, Model CU 200-P gas converter produces a prepared atmosphere through the exothermic reactions of controlled ratios of gas and air. Prepared gas is suitable for hardening, bright annealing of copper and ferrous metals, sintering, tempering and other operations.

Gages, flow meters and sampling valve are panel mounted at the proper height for inspection and adjustment. The capacity of the

*For Inquiry Card, see page 17

RCA
COMPUTER TUBES
for
Sustained Reliability



For high emission capabilities even after long periods of operation under cutoff conditions...for exceptional consistency of plate current during "On" time...for long, reliable service, specify RCA Computer Tubes. Quality performance is assured by: (1) rigid 100% microscopic inspection at every phase of tube manufacture, (2) factory tests under typical electronic computer operating conditions—including checks for cathode interface, interelectrode leakage, high-resistance, and intermittent shorts, and (3) tube life tests for conduction, standby operation, stability, and survival rate.

See your RCA Industrial Tube Distributor for the computer tube types you need. For prompt service, call him.

For free technical data on any of the following RCA Computer Tube types: 5915, 5963, 5964, 5965, 6197, 6211, 6350, 6887, write RCA Commercial Engineering, Section I-85-Z, Harrison, New Jersey.

TUBES FOR INDUSTRY
Radio Corporation of America
Tube Division Harrison, N. J.

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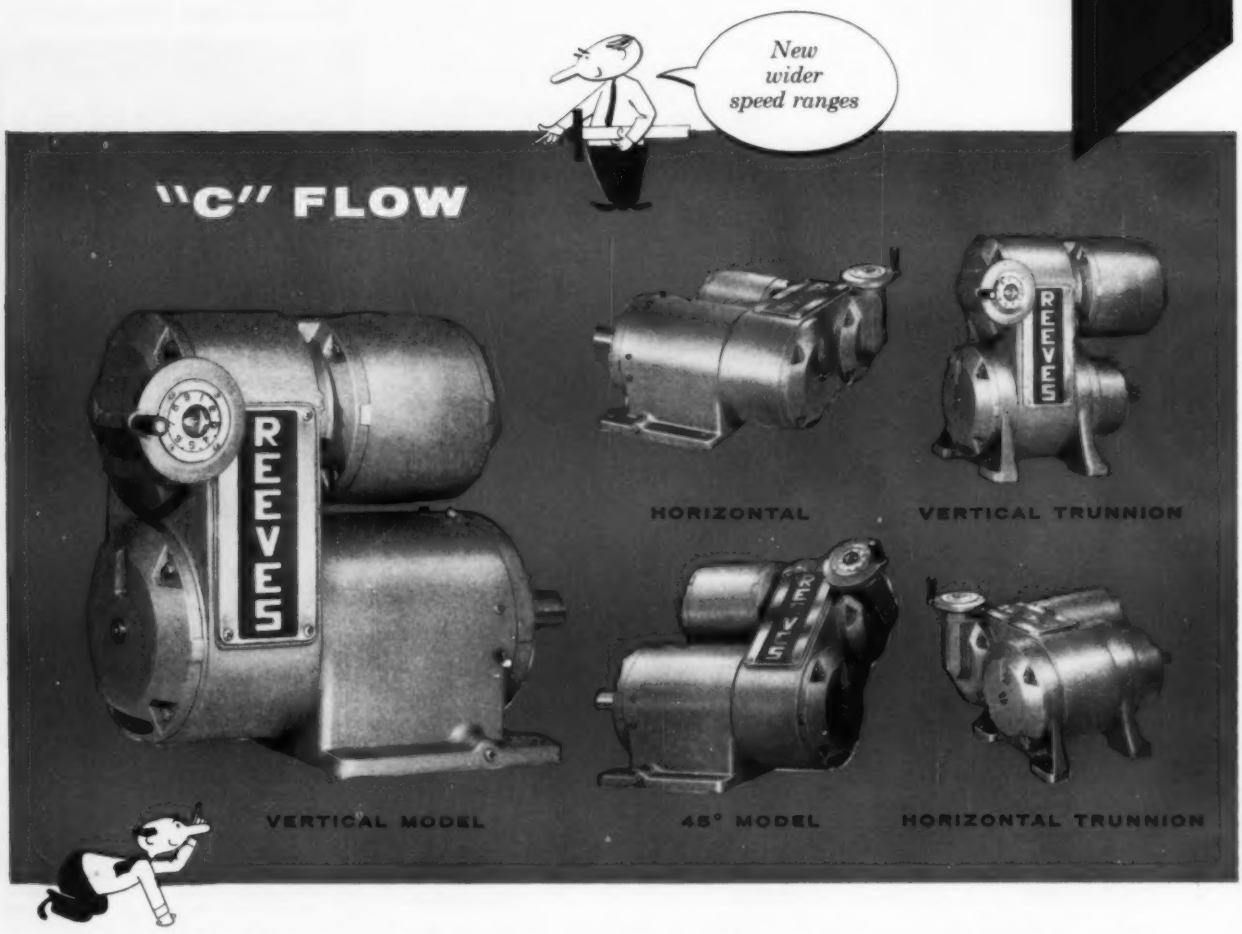
variable speed with new versatility and performance



A triumph of new Motodrive design . . . inside and out

New REEVES Vari-Speed Motodrives, sizes 200 and 300, are complete variable speed power packages, built with compactness and precision, to give improved performance on installations 1 through 5 hp.

The new sizes are designed in two styles—"C" flow and "Z" flow. In each style, there are several different models and reducers with increased capacity in single, double or triple stages.

The flexible design permits hundreds of combinations . . . space-saving, space-fitting *standard* assemblies to meet most installation requirements.

The handwheel control location can be rotated to optional positions for greater operating convenience; extra precision of control is available with the addition of one or more REEVES accessories or modifications.

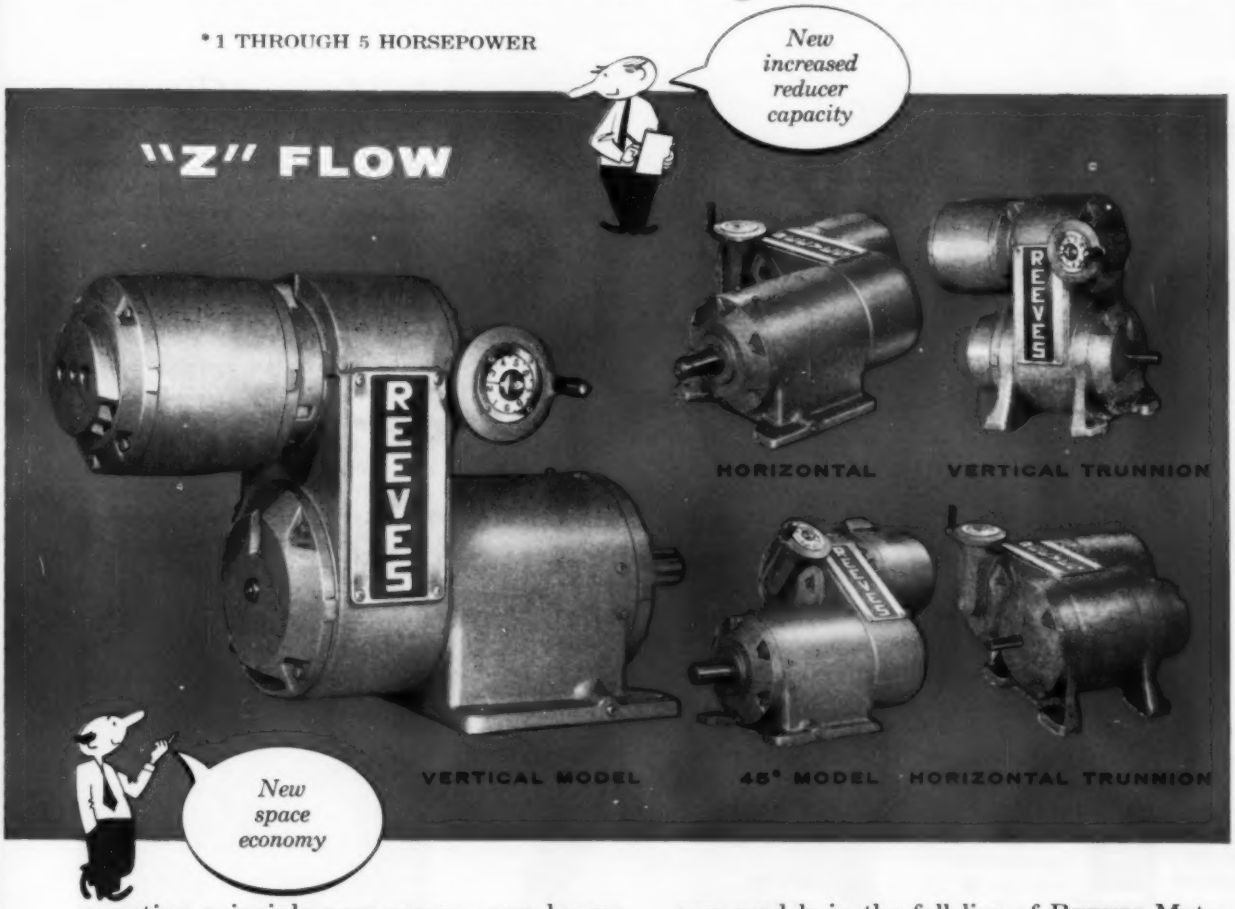
Refinements to the time-tested REEVES

NEW

REEVES®

*Sizes 200-300 Vari-Speed MOTODRIVES**

*1 THROUGH 5 HORSEPOWER



operating principle now assure even longer trouble-free service.

New disc assemblies permit wider output speed ranges . . . discs are pre-aligned . . . pre-loaded spring maintains correct belt tension for longer belt wear . . . *exclusive* "close-grooving" lubrication assures free sliding discs . . . new Metermatic system automatically lubricates the motor and variable shaft bearings.

Sizes 200 and 300 are versatile, hard-working new models in the full line of REEVES Motodrives which provide instant and accurate variable speed control on ¼ through 40 hp. applications.

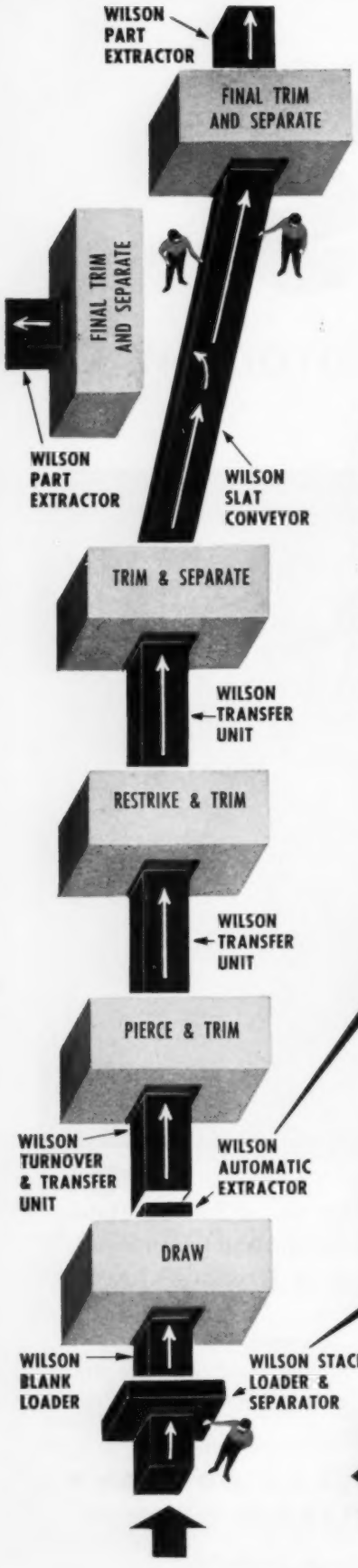
Complete details, dimensions, illustrations and prices on assemblies, modifications and accessories are in Catalog AN31-M571. Write for your free copy today.

REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

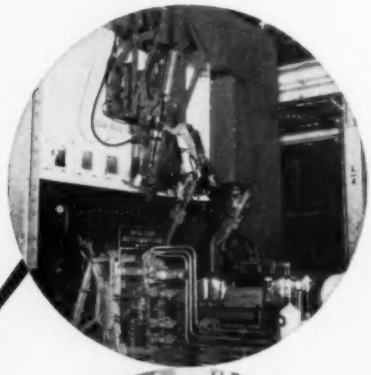
Circle 696 on Inquiry Card

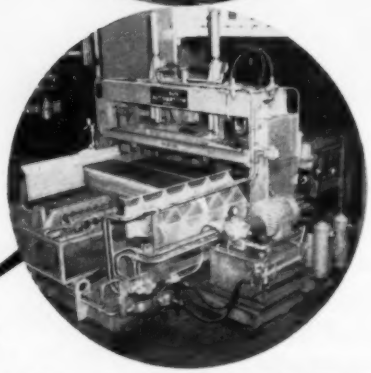


automated press line with only 3 men puts out 500 bumpers/hour

All work-load and transfer operations—from stacked blanks to completely formed bumpers—are automatically performed by Wilson Automation equipment linking the 6 presses in the bumper line shown at left. And just three workers supervise the entire 143-foot line.

Have you considered automating your manufacturing or processing operation for increased profits? Write now to reserve a copy of "Automating for Profit," a fact-filled 24-page booklet telling "when to automate and where."





WILSON AUTOMATION

27101 Groesbeck Highway at E. Eleven Mile
Write: c/o P. O. Box 3855, Detroit 5, Mich.

Automatic equipment for: loading, handling, conveying, assembling, storing, packaging, testing—for parts in process

Circle 697 on Inquiry Card

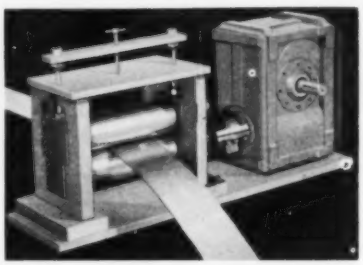
generator is 200 cu ft of prepared atmosphere per hour. **Hevi-Duty Electric Co.**, Milwaukee 1, Wis.
—*Circle 427

Dual Conveyor Cleaner

Item 428—

Automatic cleaning, phosphate coating and drying machine designed to handle a variety of metal stampings. Model CP incorporates an overhead conveyor and a flat wire mesh belt conveyor to carry stamped parts through the automatically timed cycles. The conveyors can be operated simultaneously or independently.

A single tunnel, spray system, common solution tank and headers are used for both conveyors. Individual pressure-type gas burners are used to maintain proper temperatures in each solution tank. **Alvey-Ferguson Co.**, Dept. AU, 1406 Disney St., Cincinnati 9, Ohio
—*Circle 428



Indexed Roll Feeds

Item 429—

High speed roll feeds indexed with a roller gear drive provide greater repetitive accuracy at rates up to 1000 strokes per minute. Rolls are connected by helical gearing and little or no slippage occurs at production speeds.

The roller gear drive consists of a precision cut, hardened and

*For Inquiry Card, see page 17

New Model D Single Dial CompAIRator. Available with instrument mounted gaging; or for remote connection to machining operations for in-process or post-process gaging.

New Model E. For the first time, a low-cost version of standard Taft-Peirce circuits so you can cut costs by using air gaging for many more inspection operations. Has external tolerance hands and compact cabinet. Same accuracy, same dependability — the biggest air gage value on the market.

HIGH PERFORMANCE Air Gage Line

...the TAFT-PEIRCE Model D CompAIRator

Here's another big improvement in air gaging. The well-known CompAIRator has a completely new functional design that gives you 3 big advantages: — makes air gaging easier to read, easier to use and easier to trust!

EASY TO READ — Special visor and slanted face cuts glare and reduces parallax — speeds the gaging operation. Dial has full 180° linearity.

EASY TO SET UP AND USE — Zero and range setting knobs are within easy reach of the operator. Plus, compact chassis, and simplified dial and magnification changes. The Model D can be set and used at any angle, moved easily because it's light. Can be racked or modulized.

EASY TO TRUST — Yes, you can place full confidence in the new design because it uses the proven T-P Velocity-Venturi Circuit. Repeats readings without variation, has exceptional speed of response and is readily adaptable to many special uses, including wide tolerance gaging.

Modernize your gaging with this new CompAIRator. Or, ask a Taft-Peirce representative to demonstrate the new T-P CompAIRator — you'll be amazed at the performance.

TAKE IT TO TAFT-PEIRCE

THE TAFT-PEIRCE MANUFACTURING CO., WOONSOCKET, R. I.

T-P Means TOP Precision

Circle 698 on Inquiry Card

ground tool steel cam with a tapered rib and a hub with ball or roller bearing followers. As the cam rotates, a curvature in the rib causes the hub to move one increment, resulting in a partial revolution of the rolls to feed the stock into the die. During the working time, the followers are engaged and locked with zero backlash by a straight portion of the cam rib. Device maintains 0.002 accuracy feeding some kinds of material at 500 strokes per minute. Automatic roll separators are available to allow the die to perform final locating of the material. **Roller Gear Div., Ferguson Machine Corp. of Ind.,** P. O. Box 5841, St. Louis 21, Mo.

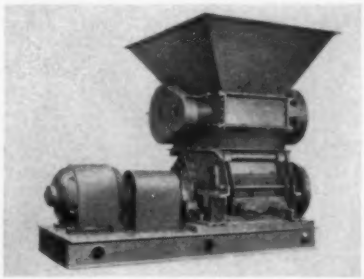
—*Circle 429

Metal-Turnings Feeder

Item 430—

An electrically controlled motor that cuts *on* and *off* according to the load is feature of metal-turnings feeder. Dual star wheels feed the metal turnings into the crusher until the amp demand controls signal *enough* and the feed shuts down temporarily until the surge load is passed.

The feeder is supported directly on the metal-turnings crusher. Hopper fits every size of crusher from a ton per hour up to 20 tons per hour. It doubles as a storage



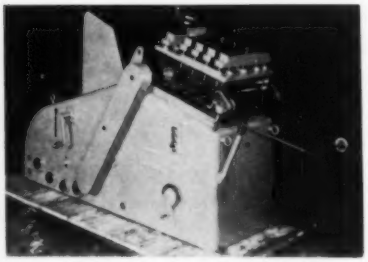
bin since the feeder motor can be started under full load. **The Jeffrey Mfg. Co.,** Columbus 16, Ohio.

—*Circle 430

Cradle & Straightener

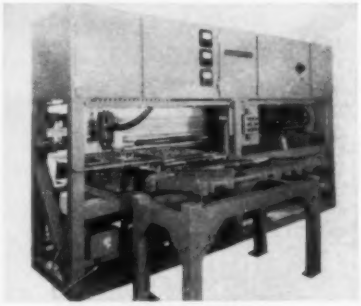
Item 431—

Unit suitable for material 16-inches wide, coils with OD up to 48-inches is designated Model



PDSC-1648. Cradle is equipped with 4 power driven rest rolls, one idler rest roll and one bumper roll. Straightener has 8 hardened and ground straightening rolls, indicators on upper rolls and 2 hardened and ground power driven take-in rolls. The combination coil cradle and straightener has a 3 hp motor and operates at output speeds of 26 to 76 fpm on 220/440v, 3 phase, 60 cycle ac. **U. S. Tool Co. Inc.,** Ampere, East Orange, N. J.

—*Circle 431



Axle Hardening Unit

Item 432—

Suitable for heavy tractor axles, unit has a production rate of approximately 300 axles per 16 hour day.

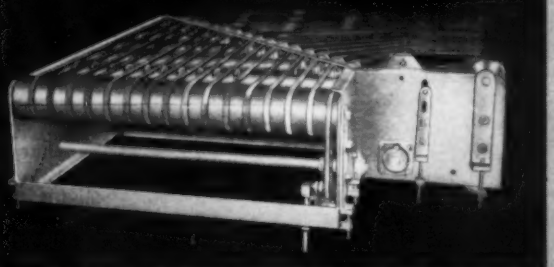
As the axles are received on the magazine rack, they are oriented by an operator and automatically moved on an indexing conveyor to a loading position. They are raised between centers by elevator blocks and carried through the hardening cycles. After the heat treat, the axles are lowered to a conveyor at the rear of the machine.

A Mot-O-Trol motor controller regulates the axle's carriage speed so progressive heating and quench can be preset to accurate standards. **Westinghouse Electric Corp.,** Box 2278, Pittsburgh, Pa.

—*Circle 432

NEW STEWART-TURN

the 90° turn that really works!

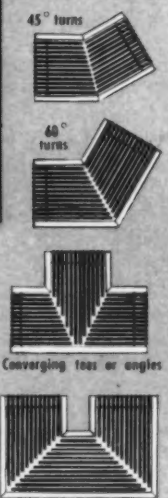


Turning 90° corners is no longer a problem or bottleneck in material handling systems. The unique Stewart-Turn moves material around corners as easily as in a straight line! No rollers to stick, tight corners to jam or deflectors to damage the material being moved. Never before has this been possible!

The Stewart-Turn is a series of narrow-faced belts, running in grooved pulleys, banked for constant contact with the material in motion. A slight differential in speed between the bank of belts produces a positive turning action, with belts spaced to carry small as well as large or long articles. Belt friction reaction to turning has been eliminated.

Stewart-Turns, as well as all Stewart-Glapat material handling equipment and conveyors, are CUSTOM DESIGNED TO YOUR JOB. If you are looking for advanced engineering thinking for your material handling or automation problems, WRITE STEWART-GLAPAT TODAY, and ask for complete details on the sensational, new Stewart-Turn!

A few other applications of versatile Stewart-Turns.



STEWART-GLAPAT Corporation

1645 Moxahala Avenue, Zanesville, Ohio

*For Inquiry Card, see page 17

Automation

... for a plant

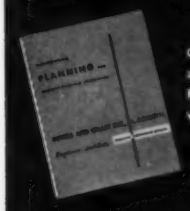
a department

an operation

Frequently, the design of a single machine, or piece of equipment will do the job.

Whether a business is big or small, the correct application of automated equipment will increase output . . . improve product quality . . . and lower unit costs. And it can be done on a practical, cost-recovery basis! Determining whether you need automation or mechanization, *and how much or how little*, is a job that requires seasoned professional engineering experience with its attendant insights into production problems common to many industries.

Tailoring automation to meet your needs, through the design and development of automated production equipment, is among the major services offered by Giffels & Vallet. It is a service which can establish a new standard of production efficiency in your plant.



Giffels & Vallet services are discussed in a special Planning Brochure. A copy will be mailed on request.

INDUSTRIAL ENGINEERING DIVISION

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Engineers Serving Industry for Over Thirty Years

Plant Layout • Process Development • Automation Engineering • Materials Handling • Machine Design • Building Design

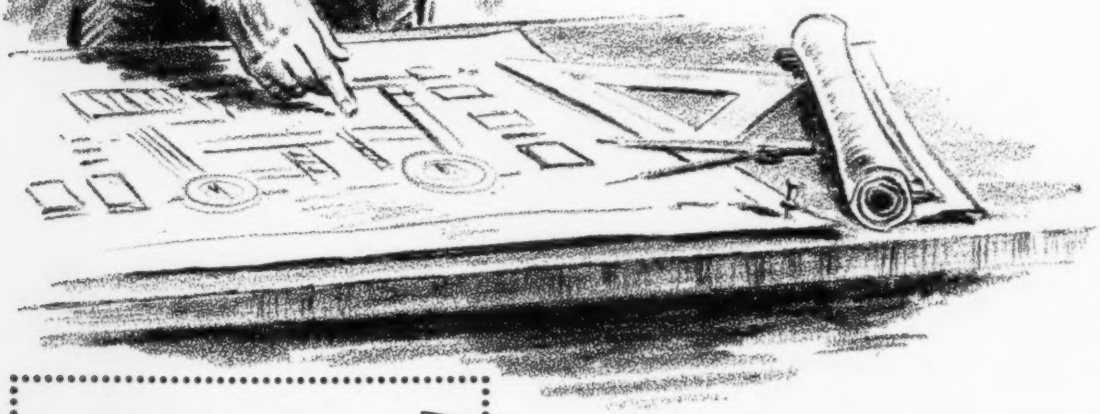
DESIGN

with AIR in mind

Take a new look at that design.
What can you save by eliminating cams, gears, levers or mechanical linkages?
What can you gain?

By replacing mechanical means of performing repetitive push, pull, lift or turn motions with Bellows "Controlled-Air-Power," in most cases you'll cut the cost of building the machine. In virtually all cases you'll improve machine performance — and machine appearance.

Design with air in mind. Take advantage of the economics possible with Bellows "Controlled-Air-Power" Devices. These versatile, inexpensive, easily installed packaged pneumatic work units will perform any repetitive push, pull, lift or turn motion with speed and precision.



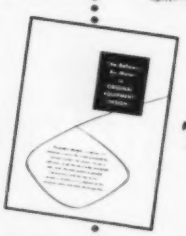
READ THIS STORY—

"The Place of the Bellows Air Motor in Original Equipment Design."

This new 14 page booklet will be of help to any design engineer.

Write Dept. AU957
The Bellows Co., Akron 9, Ohio

In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto, Ontario



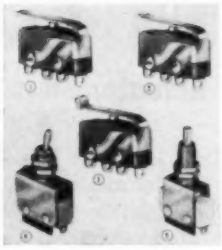
The Bellows Co.
AKRON 9, OHIO

893-B

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 17.



Switch Actuators

Item 433—

Leaf, frame leaf, roller leaf, plunger and toggle models developed for use with new sub-miniature switch. Actuators available for switch which is ¾-inch in length. Rated 10 amp at 125-250v ac; ¼ hp 125v ac; and 10 amp 28v dc, switch has a double throw, double circuit design. **Acro Div., Robertshaw-Fulton Controls Co.,** Columbus 16, Ohio

—*Circle 433

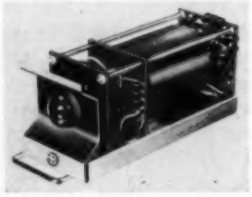
Variable Speed System

Item 434—

Unit capable of automatically changing speeds of several motors equally and simultaneously consists of a power unit, one or more induction motors and an automatic pneumatic control system. Application of the automatic control provides more positive control and reduces need for frequent readjustment of motor speeds.

Signal to the control unit can be obtained from many standard control instruments affected by variables such as temperature, pressure, humidity, weight and velocity. The system provides variable frequency power to the motors, which are linked together electrically. Speed changes at the power unit cause the speed of each motor in the system to vary equally or proportionately. System is suitable for materials handling and conveying applications. **U. S. Electrical Motors Inc.,** Box 2058 Terminal Annex, Los Angeles 54, Calif.

—*Circle 434

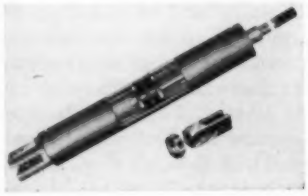


Decade Counter

Item 435—

Display of numerical information that is directly controlled by a single counter tube is feature of decade counter. In-line figures are visible from 30 to 40 ft. Unit has estimated counter tube life of approximately 50,000 hr. Three models are available covering the 10 kc, 100 kc and 1 mc range. **Electronic Tube Div., Burroughs Corp.,** Plainfield, N. J.

—*Circle 435



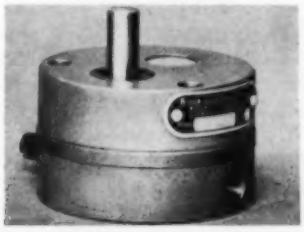
Fork-Type Cylinders

Item 436—

Models AN and BN feature a fork-type rear head for mounting, stainless steel rods, Nylined bearings, high tensile aluminum heads, honed brass or steel tubing treated for corrosion resistance and adjustable cushions for either end.

Cylinders are offered in 7 bore sizes from ⅞ to 4-inches. Model AN uses O-ring packing for piston head seals and Model BN uses cups. Both types are available as double acting or single acting with spring return. **A. K. Allen Co.,** 57 Meserole Ave., Brooklyn 22, N. Y.

—*Circle 436



Sealed Gear Pump

Item 437—

Unit can be mounted on any machine requiring fluid circulation for lubrication or other purposes. Driven from a rotating machine shaft either directly or through a

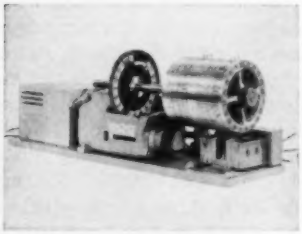
*For Inquiry Card, see page 17

gear or chain drive of suitable ratio, the pump is applicable to any machine requiring flood lubrication over gear trains, chains or cams. Venting of pressure to the inlet of the pump by means of a pressure relief system reduces the possibility of operational failure.

Measuring 2½-inches in diameter, the pump can be mounted either on its shaft side or on the opposite face. When mounted on the shaft side, a concentric recess permits lining up drive shaft with pump shaft for free operating conditions. The pump can be driven in either direction, the direction of drive determining the inlet and outlet ports. Two built-in safety valves are included, one for each direction of flow.

Discharge is 50 cu cm per minute at 100 rpm; speed range is 20 to 1000 rpm. **Bijur Lubricating Corp.,** 151 W. Passaic St., Rochelle Park, N. J.

—*Circle 437



Program Timer

Item 438—

Recycling, circuit - controlling counter that responds to mechanical or electrical inputs of variable speeds becomes a timer when equipped with a constant speed drive. Synchronous motor is connected to the chassis with a drive shaft. The chassis carries the switches and leads which form the control circuit.

Selecting and adjusting the overall time cycle is achieved by moving a pointer on the main dial gear for the units and tens of the desired figure, and turning a dial knob for the hundreds, indicated on a scale on the side of the chassis. Removable switch pins are inserted in holes corresponding to the desired intervals in the time cycle. As the cylinder rotates, the switch pins pass over sensing switches to provide intermediate switching events within the overall time cycle. Correct switch pin holes are located by means of a reference grid system using numbered dials on each end of the cylinder and tracer lines at 500-second intervals along the length of the cylinder.

The unit is rated at 115v, 60 cycles, single phase with a motor speed of 60 rpm. **Counter & Control Corp.,** 5213 W. Electric Ave., Milwaukee 19, Wis.

—*Circle 438

Contact Gages

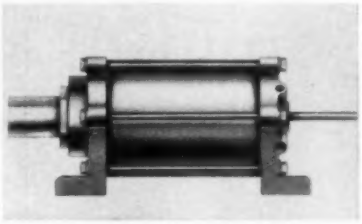
Item 439—

Designed for speeding up inspection of mass produced parts while maintaining a high standard of accuracy, unit permits instant observation of gaging results by flashing lights in a signal light attachment.

Attachment reports accurately within 20 millionths of an inch, over and undersize as well as correct size by flashing of green, red or yellow light. Automatic controlling devices can be attached to a second socket of the signal light box. An acoustic signal can be sounded allowing blind persons to be employed as inspectors. Changes in dimensions beyond tolerance limits can be announced acoustically in comparators checking running work which need not be observed continuously. Small parts can be segregated according to gaging results through switches controlled by the electric limit contacts, and the work guided into various sorting channels. Installing auxiliary relays in the control circuit allows the use of heavier devices with a larger electric load.

Units are offered in two basic types, with and without dial. Dial type will permit observation of the position relative to tolerance limits in addition to the action of the signal lights. **George Scheer Co. Inc.,** 200 Lafayette St., New York 12, N. Y.

—*Circle 439



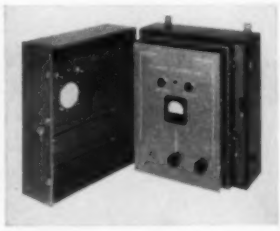
Servo Actuator

Item 440—

Hydraulic unit may be mechanically driven by means of cable or rods, or electrically by servo motor, synchro, or solenoid. The output and input circuits are hydraulically inter-related and the output shaft automatically takes the position commanded by the input shaft.

Servo valve rotary actuator is composed of two basic elements: a rotating input shaft coupled to a slide type valve and a rotating output shaft attached to a set of movable vanes. One set of vanes moves through an arc of 270 degrees. For greater torque requirements a second set of vanes can be incorporated, and rotation is limited to 95 degrees. **Industrial Control Products Inc.,** Caldwell, N. J.

—*Circle 440



Safety Control

Item 441—

Capacitance device protects personnel operating dangerous machinery as found in the steel, metal working, and paper box industries. The presence of a person, or person's hand in the danger area is instantly sensed and an electrical

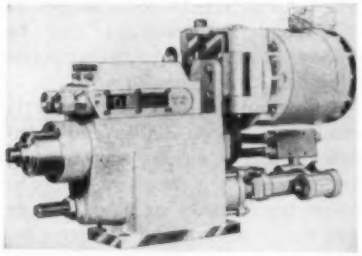
*For Inquiry Card, see page 17

signal sent to the machine braking mechanism.

Size and shape of the safety field are determined by the positioning of the sensing element and control adjustments. Failure of any electrical component causes the machine to stop. Electronic tubes are readily accessible for checking, and the inner chassis is removable. Cabinet is shock-mounted and gasketed, and has a lock and key.

Sensing elements of different sizes and shapes can be used for the set-up of a particular field to protect a specific area. **Security Controls Inc.**, 257 Franklin St., Buffalo 2, N. Y.

—*Circle 441



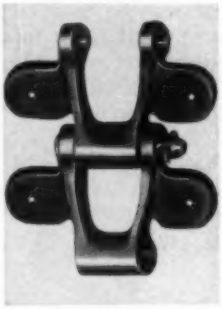
Drilling Unit

Item 442—

Unit suitable for high speed drilling, reaming, counterboring, precision boring, and spot facing. Adjustable air-powered advance to the work, controlled hydraulic feed of the spindle, and adjustable air-powered rapid return are features of Model BEM-10.

Amount of rapid advance and depth of feed are electrically controlled, easily adjusted by two external calibrated control knobs. Unit has a fully adjustable stroke length from 1½ to 4 inches with optional stops available for zero to 4 inches for the rapid advance or hydraulic feed portion of the stroke. Drilling capacity is up to ⅝-inch diameter drill in mild steel with standard 2 hp motor. Spindle and quill assembly are built as an integral unit for easy removal from the main housing. Fit of the quill to the bore of the main housing is within 0.0002 to 0.0003 inch. Total runout of spindle to the base mounting surface will not exceed 0.0005 tir in the full 4-inch stroke of the unit. Thirty-five spindle speeds ranging from approximately 600 rpm to 6000 rpm are available by changing timing belt and motor pulley. **Bellows Co.**, Akron, Ohio.

—*Circle 442



Conveyor Chain

Item 443—

Designed for easy assembly or disassembly, conveyor chain link is made with a wing attachment for joining wood or metal conveyor slats for all types of duty. It can be used in single or multiple strands.

Each pin type chain is locked against rotation. Sprockets and complete conveyor aprons can be supplied using this chain. **Robert A. Main & Sons Inc.**, 257 Pascack Rd., Paramus, N. J.

—*Circle 443

Electrical Switches

Item 444—

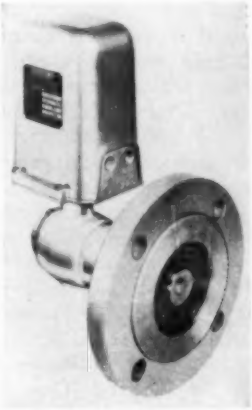
Molded wrap-around covers which contain and protect the contact mechanism are feature of pushbutton and selector switches. Removing the cover exposes the wiring terminals in the base. A molded shield covers and protects the contact mechanism when the cover is removed.

Base terminals are connected to the pushbutton assembly in the cover through heavy, silver plated contacts. Matching ribs in the cover and notches in the base make it impossible to mount the cover in the wrong way. Concentric knockouts are provided in both top and bottom of the metal base for convenient wiring and the pushbuttons can be rotated 90 degrees for mounting the station in a horizontal position.

Selector switches can be changed from a two position to a three position switch in a matter of seconds by loosening two screws, rotating a metal plate through 90 degrees and tightening the screws again. A strip of seven name plates is furnished with each selector switch to meet any designation required.

Units are rated at 3 amp, 110v, 2 amp 220v, 1 amp, 440-550v ac and 1 amp, 115v, 0.5 amp, 230v, and 0.2 amp, 550v dc. **Allen-Bradley Co.**, 136 W. Greenfield Ave., Milwaukee 4, Wis.

—*Circle 444



Liquid Level Transmitter

Item 445—

Unit mounts directly on a tank nozzle to provide a simple method for measuring level of viscous or slurry-type liquids in open or closed vessels. Operating on the force balance principle, Model 13 FA d/p cell transmitter maintains calibrated accuracy over a wide range of ambient conditions.

The level measuring element, a silicone-filled diaphragm capsule, is assembled in a 3-inch flange for

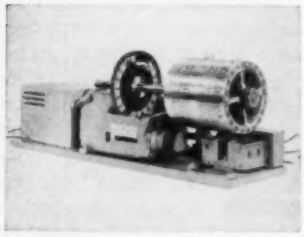
*For Inquiry Card, see page 17

gear or chain drive of suitable ratio, the pump is applicable to any machine requiring flood lubrication over gear trains, chains or cams. Venting of pressure to the inlet of the pump by means of a pressure relief system reduces the possibility of operational failure.

Measuring 2½-inches in diameter, the pump can be mounted either on its shaft side or on the opposite face. When mounted on the shaft side, a concentric recess permits lining up drive shaft with pump shaft for free operating conditions. The pump can be driven in either direction, the direction of drive determining the inlet and outlet ports. Two built-in safety valves are included, one for each direction of flow.

Discharge is 50 cu cm per minute at 100 rpm; speed range is 20 to 1000 rpm. **Bijur Lubricating Corp.,** 151 W. Passaic St., Rochelle Park, N. J.

—*Circle 437



Program Timer

Item 438—

Recycling, circuit - controlling counter that responds to mechanical or electrical inputs of variable speeds becomes a timer when equipped with a constant speed drive. Synchronous motor is connected to the chassis with a drive shaft. The chassis carries the switches and leads which form the control circuit.

Selecting and adjusting the overall time cycle is achieved by moving a pointer on the main dial gear for the units and tens of the desired figure, and turning a dial knob for the hundreds, indicated on a scale on the side of the chassis. Removable switch pins are inserted in holes corresponding to the desired intervals in the time cycle. As the cylinder rotates, the switch pins pass over sensing switches to provide intermediate switching events within the overall time cycle. Correct switch pin holes are located by means of a reference grid system using numbered dials on each end of the cylinder and tracer lines at 500-second intervals along the length of the cylinder.

The unit is rated at 115v, 60 cycles, single phase with a motor speed of 60 rpm. **Counter & Control Corp.,** 5213 W. Electric Ave., Milwaukee 19, Wis.

—*Circle 438

Contact Gages

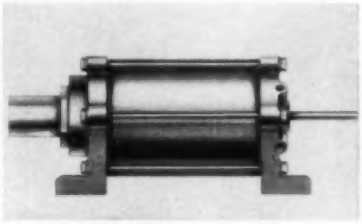
Item 439—

Designed for speeding up inspection of mass produced parts while maintaining a high standard of accuracy, unit permits instant observation of gaging results by flashing lights in a signal light attachment.

Attachment reports accurately within 20 millionths of an inch, over and undersize as well as correct size by flashing of green, red or yellow light. Automatic controlling devices can be attached to a second socket of the signal light box. An acoustic signal can be sounded allowing blind persons to be employed as inspectors. Changes in dimensions beyond tolerance limits can be announced acoustically in comparators checking running work which need not be observed continuously. Small parts can be segregated according to gaging results through switches controlled by the electric limit contacts, and the work guided into various sorting channels. Installing auxiliary relays in the control circuit allows the use of heavier devices with a larger electric load.

Units are offered in two basic types, with and without dial. Dial type will permit observation of the position relative to tolerance limits in addition to the action of the signal lights. **George Scheer Co. Inc.,** 200 Lafayette St., New York 12, N. Y.

—*Circle 439



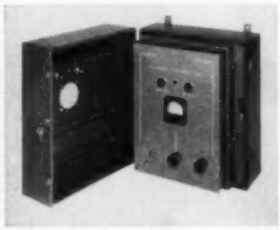
Servo Actuator

Item 440—

Hydraulic unit may be mechanically driven by means of cable or rods, or electrically by servo motor, synchro, or solenoid. The output and input circuits are hydraulically inter-related and the output shaft automatically takes the position commanded by the input shaft.

Servo valve rotary actuator is composed of two basic elements: a rotating input shaft coupled to a slide type valve and a rotating output shaft attached to a set of movable vanes. One set of vanes moves through an arc of 270 degrees. For greater torque requirements a second set of vanes can be incorporated, and rotation is limited to 95 degrees. **Industrial Control Products Inc.,** Caldwell, N. J.

—*Circle 440



Safety Control

Item 441—

Capacitance device protects personnel operating dangerous machinery as found in the steel, metal working, and paper box industries. The presence of a person, or person's hand in the danger area is instantly sensed and an electrical

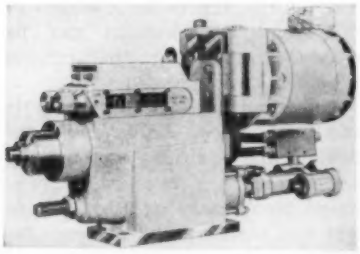
*For Inquiry Card, see page 17

signal sent to the machine braking mechanism.

Size and shape of the safety field are determined by the positioning of the sensing element and control adjustments. Failure of any electrical component causes the machine to stop. Electronic tubes are readily accessible for checking, and the inner chassis is removable. Cabinet is shock-mounted and gasketed, and has a lock and key.

Sensing elements of different sizes and shapes can be used for the set-up of a particular field to protect a specific area. **Security Controls Inc.,** 257 Franklin St., Buffalo 2, N. Y.

—*Circle 441



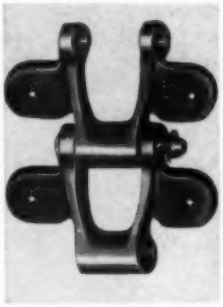
Drilling Unit

Item 442—

Unit suitable for high speed drilling, reaming, counterboring, precision boring, and spot facing. Adjustable air-powered advance to the work, controlled hydraulic feed of the spindle, and adjustable air-powered rapid return are features of Model BEM-10.

Amount of rapid advance and depth of feed are electrically controlled, easily adjusted by two external calibrated control knobs. Unit has a fully adjustable stroke length from 1½ to 4 inches with optional stops available for zero to 4 inches for the rapid advance or hydraulic feed portion of the stroke. Drilling capacity is up to ⅝-inch diameter drill in mild steel with standard 2 hp motor. Spindle and quill assembly are built as an integral unit for easy removal from the main housing. Fit of the quill to the bore of the main housing is within 0.0002 to 0.0003 inch. Total runout of spindle to the base mounting surface will not exceed 0.0005 tir in the full 4-inch stroke of the unit. Thirty-five spindle speeds ranging from approximately 600 rpm to 6000 rpm are available by changing timing belt and motor pulley. **Bellows Co.,** Akron, Ohio.

—*Circle 442



Conveyor Chain

Item 443—

Designed for easy assembly or disassembly, conveyor chain link is made with a wing attachment for joining wood or metal conveyor slats for all types of duty. It can be used in single or multiple strands.

Each pin type chain is locked against rotation. Sprockets and complete conveyor aprons can be supplied using this chain. **Robert A. Main & Sons Inc.,** 257 Pascack Rd., Paramus, N. J.

—*Circle 443

Electrical Switches

Item 444—

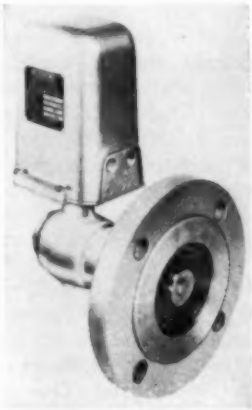
Molded wrap-around covers which contain and protect the contact mechanism are feature of pushbutton and selector switches. Removing the cover exposes the wiring terminals in the base. A molded shield covers and protects the contact mechanism when the cover is removed.

Base terminals are connected to the pushbutton assembly in the cover through heavy, silver plated contacts. Matching ribs in the cover and notches in the base make it impossible to mount the cover in the wrong way. Concentric knockouts are provided in both top and bottom of the metal base for convenient wiring and the pushbuttons can be rotated 90 degrees for mounting the station in a horizontal position.

Selector switches can be changed from a two position to a three position switch in a matter of seconds by loosening two screws, rotating a metal plate through 90 degrees and tightening the screws again. A strip of seven name plates is furnished with each selector switch to meet any designation required.

Units are rated at 3 amp, 110v, 2 amp 220v, 1 amp, 440-550v ac and 1 amp, 115v, 0.5 amp, 230v, and 0.2 amp, 550v dc. **Allen-Bradley Co.,** 136 W. Greenfield Ave., Milwaukee 4, Wis.

—*Circle 444



Liquid Level Transmitter

Item 445—

Unit mounts directly on a tank nozzle to provide a simple method for measuring level of viscous or slurry-type liquids in open or closed vessels. Operating on the force balance principle, Model 13 FA d/p cell transmitter maintains calibrated accuracy over a wide range of ambient conditions.

The level measuring element, a silicone-filled diaphragm capsule, is assembled in a 3-inch flange for

*For Inquiry Card, see page 17

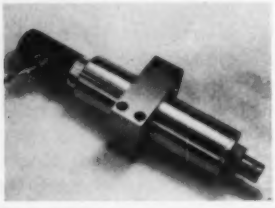
flush mounting on the side of a vessel. Head of liquid in the vessel applies force to the high pressure side of the capsule which is opposed by force on the low pressure side. This side can be open to atmosphere for measurement of open tank level or connected by piping to the top of a closed tank to balance out static pressure. Output is a 3 to 15 psi pneumatic signal proportional to tank level. **Foxboro Co.,** Foxboro, Mass.
—*Circle 445

Gearmotor

Item 446—

Unit has heavy load-carrying and shock-absorbing qualities for industrial applications. Choice of horizontal or vertical mountings, conventional double shaft, and hollow shaft allow meeting all requirements for reduced speeds. One-piece reducer housing contains a pair of helical gears for the primary reduction and a patented double-enveloping worm gear set for the secondary reduction.

Gearmotors are available in 1 to 10 hp sizes for continuous-duty applications, and 1 to 30 hp for intermittent duty. **Reliance Electric & Engineering Co.,** 24701 Euclid Ave., Cleveland 17, Ohio.
—*Circle 446



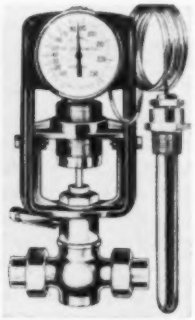
Valve-Cylinder Assembly

Item 447—

Suitable for clamping, locating or push-off of parts. Solenoid-operated three-way valve is mounted on a square non-rotating rod air cylinder. Foot, hand or limit switches can be used to energize the unit, which operates on 110 or 220v, 60 cycles.

The valve is easily removed from the cylinder, leaving a standard pipe port exposed in the cylinder. Both units can be used separately if desired. Split block mountings allow adjustment over the length of the cylinder without removing the unit from the fixture.

Device is offered with 1, 1½ and 2-inch bores; 1, 2, 3 and 4-inch strokes. **Beckett-Harcum Co.,** 1087 Wayne Rd., Wilmington, Ohio.
—*Circle 447

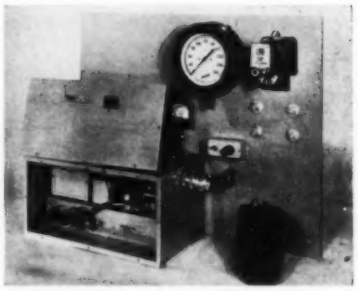


Regulator Unit

Item 448—

Industrial processes and hot water systems can be checked and automatically controlled by self-operating indicator-regulator. Front-mounted dial thermometer provides continuous temperature readings of the process under control. Regulator governs temperature and provides uniform control.

Unit consists of a thermal bulb connected by flexible tubing to a diaphragm bellows. The bellows operates a valve mounted in the pipe line to be controlled. The bulb, filled with a volatile fluid, is placed in the tank, vat, or line where temperature is to be regulated. Any temperature changes will vary the pressure of the volatile fluid. Pressure is transmitted to the bellows which operates the valve gradually to hold the process at a constant temperature. Regulator ranges are available to permit control as low as 60 F and as high as 260 F. **Powers Regulator Co.,** 3434 Oakton St., Skokie, Ill.
—*Circle 448

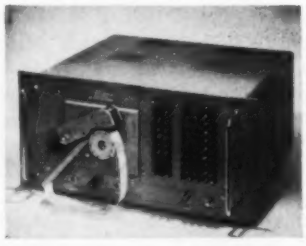


Flow Measuring System

Item 449—

Device measures the flow of gas through an orifice plate by means of electrical signals proportional to the flow rate and accumulated flow. An adapter adjusts the instrument's calibration to the conditions of the measurement problem. Adjustments for changes in the measuring problem can be made by changing the plug-in adapter.

The computer includes magnetic amplifiers, silicon diodes and transistors and contains no moving parts. It has a pressure compensation input range of 0 to 120 per cent and a differential pressure input range of 0 to 100 per cent. The speed of response is three-hundredths of a second for 63.2 per cent of full scale change and accuracy is within 1 per cent of full scale output with 20 per cent or more flow. The system can also be used to control or monitor the flow of liquid or gas. **Computers Inc.,** 2025 Harold St., Houston 6, Texas.
—*Circle 449

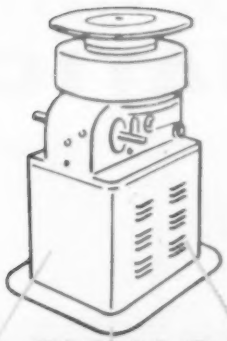


Tape Reader

Item 450—

Suitable where tape or card programming and data storage are used, unit simultaneously reads 10 transverse rows of 8 holes each in

*For Inquiry Card, see page 17

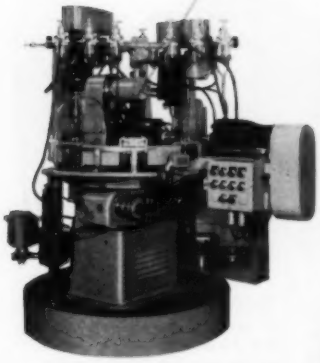


COMMON DENOMINATOR FOR SPECIAL MACHINES

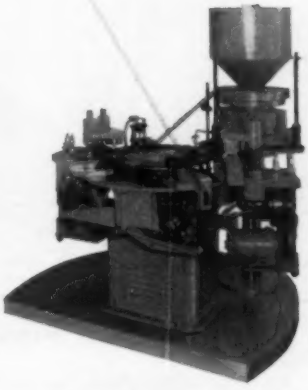
The three machines shown below were designed and built by Swanson-Erie for three different clients, to perform widely different operations. But all have one important common feature—**each incorporates a SWANSON turret indexing machine chassis.**

These chassis are the result of long experience in designing and building complete special automatic machines. Tested and accepted by years of use, they offer, at low cost, the basis for the most complex automatic machines—with many possible tool camming arrangements—easy tool mounting adaptation—smooth, positive index—consistently accurate, rigid dwell.

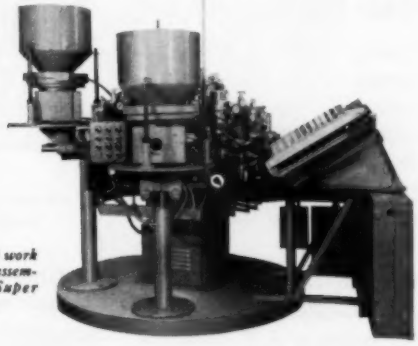
If you are responsible for special automatic machines, be sure to include Swanson Indexing Machine Chassis in your planning. *Write for illustrated Bulletin 356.*



8 index position semi-automatic machine for drilling, tapping and counterboring die cast cigarette lighter parts.



8 index position automatic machine for feeding, loading, piercing, lancing and stenciling stamped volume-control cans.

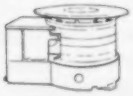


16 index position (32 work stations) automatic assembly machine for Super Speed safety razors.

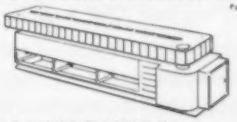
SEC
SINCE 1919
SWANSON-ERIE
CORPORATION
814 EAST EIGHTH ST., ERIE, PA.

OVER 200 STANDARD MODELS OF INDEXING MACHINE CHASSIS

Series B & C Turret Index Models—for medium and light applications.



Series H Turret Index Models—for heavy duty applications.



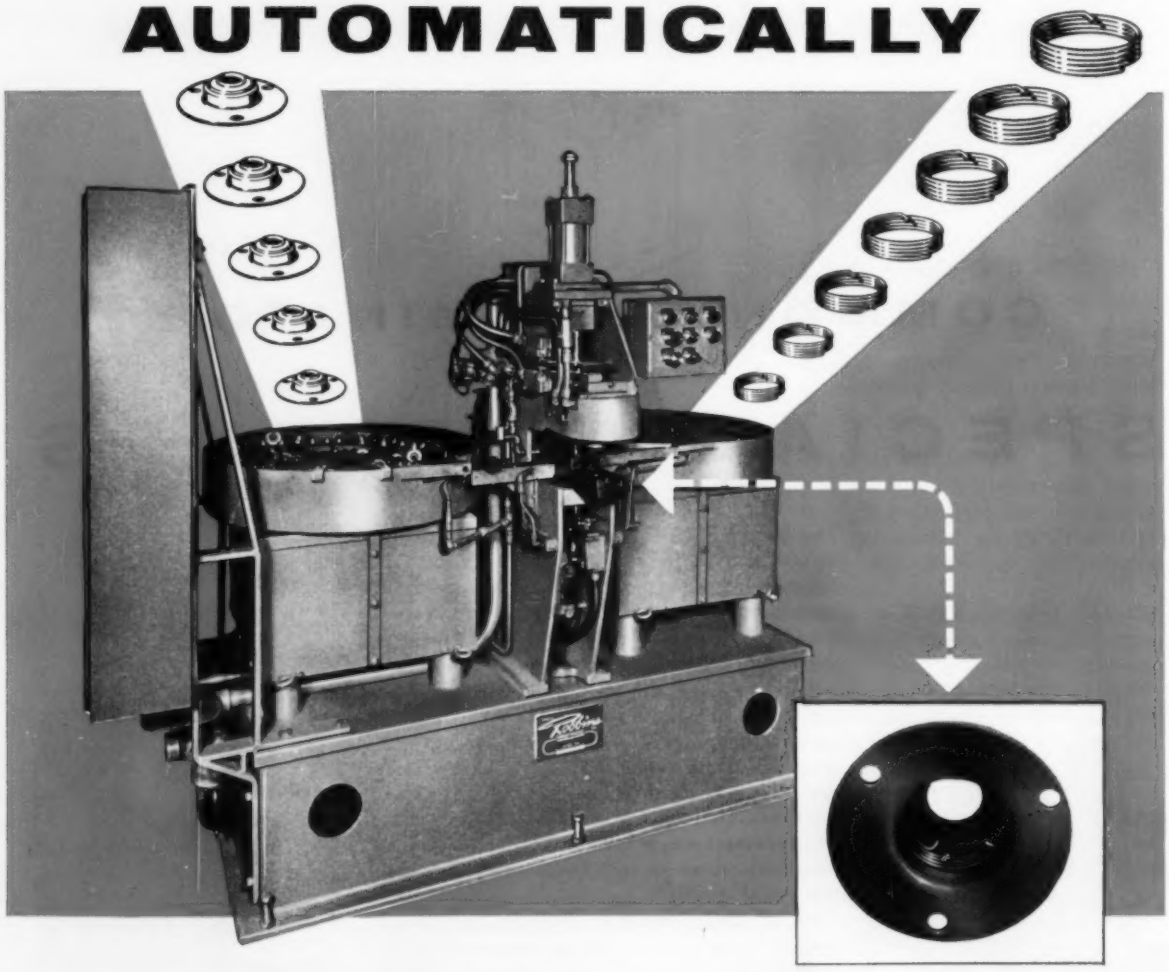
Series L Auto-Tran Straight Line Indexing Chassis—for automatic or semi-automatic assembly and processing operations.

Series K Turret Index Models—for heavy duty applications with center column tool mounting.

ENGINEERS AND BUILDERS OF SPECIAL AUTOMATIC MACHINES

FEEDS, POSITIONS, ASSEMBLES, UNLOADS

AUTOMATICALLY



1,440 INTRICATE SPRING-STAMPING ASSEMBLIES PRODUCED EVERY HOUR!

An automatic machine that installs *coil springs?* Right! . . . it's the new Robbins "Assemblimatic" Twin Feed Special. Two parts, a spring and stamped housing for an automotive window regulator, are hopper-fed into a hat-shaped track . . . housing open side up. The spring is fed over it, compressed and pressed into place. A second ram holds the spring . . . the housing is rotated until spring end is properly located in relation to housing holes . . . the finished assembly is unloaded, *at the rate of 1,440 assemblies per hour at 90% efficiency.*

In addition to completely automatic operation the machine features: electronic production control; automatic lubrication; hardened and ground ways; electrical and pneumatic equipment to J.I.C. standards, and *compactness* . . . the machine measures 82″ wide x 38″ deep x 70″ high and weighs less than 5,000 pounds.

Robbins "Assemblimatic" Machines are, *in fact*, the right answer to a wide range of assembly problems. They have cut manpower requirements, increased production, improved quality, reduced scrap in many mass production operations . . . and, chances are they can do the same for you. Find out now! Call in a Robbins special assembly machine engineer today, or send part prints for detailed recommendations.

New brochure describes and illustrates a variety of Robbins special assembly machines. Write for your copy today.

We offer complete facilities and qualified personnel to undertake special development projects.

OMER E. ROBBINS COMPANY
24806 PLYMOUTH ROAD • DETROIT 39, MICH.

Robbins

SPECIAL MACHINES

a perforated tape, can supply 80 bits of information for each event without the use of memory circuits.

Tape reader accommodates 1-inch tapes with holes on 1/10-inch centers. Panel of neon lamps duplicates the 8 by 10 hole pattern of an entire frame and is used to rapidly check newly punched tapes. Thirty-five milliseconds are required to advance the tape to a new frame. Stepping can be controlled manually or automatically by a simple circuit closure in the accompanying equipment.

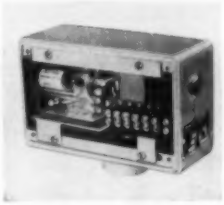
Contacts are rated at 50 ma and connections to the contacts are made through two 50-pin connectors at the back of the unit. Common return is made through the drum which drives the tape. Operated by a motor and clutch, the drum indexes the tape without kickback or overshoot. Power is single-phase, 60 cps, 375w. **California Technical Industries,** 1415 Old County Rd., Belmont, Calif.
—*Circle 450

Automatic Gaging System

Item 451—

Automatic gaging, sorting, or size control with an accuracy of 0.00001-inch is design of system. Unit consists of Model 100 Displacement Transmitter and Model 562 Limit Controller. Transmitter is mounted in a gaging fixture, and limit points or tolerance values are preset on digital dials. Controller makes decision in 0.05 second and energizes output relays that can be used to actuate reject or marking devices, sorting gates or alarms.

Inputs can be programed from punched cards or other data storage devices for complete automatic control of complex machining processes. Two independently adjustable set points, each with *over-under* indicator lamps and output relay are included. **Daytronic Corp.,** 216 So. Main St., Dayton 2, Ohio
—*Circle 451



Photoelectric Relays

Item 452—

Adaptable for every factory condition including wetness, dirt, vibration, shock, temperature, humidity and voltage fluctuation, photoelectric relays are designed without amplifier tubes. Model RPF3 (shown) is adjustable from outside, operable from as low as one ft-c, and sensitive to a 10-20 per cent change in illumination because of its bridge-type circuit. Also offered is Model RPF1, a general purpose, low cost non-adjustable photo relay that operates at low light levels, is highly directional, and controls 5 amp SPDT contacts. Each variety operates directly from 100-130v, 60/50 cycles and controls its own internal relay. **Photobell Co. Inc.,** 43 Vesey St., New York 7,
—*Circle 452

Gas Density Balance

Item 453—

Unit is applicable to continuous density measurements of hydrocarbon process streams; continuous hydrogen readings on blanketed generators, and other applications where specific gravity or density provides an index to gas stream properties. Model 3A measures the density of a sample gas by a null balance principle. A small dumbbell is supported on a horizontal quartz fiber. One ball of the dumbbell is punctured so it will not experience bouyancy effects. The other ball tends to rise or dip as the density of the gas increases or decreases. The dumbbell experiences a rotational force about the quartz fiber as it responds to density changes. The magnitude of this force is proportional to the density of the sample gas.

Sensitivity is approximately ½ per cent of full scale; accuracy 1½ per cent. Standard output is 0.5 mv, with other spans obtainable. Instrument is housed in a vapor-tight steel case with range selector switch and operating controls mounted on the door. **Arnold O. Beckman Inc.,** 1020 Mission St., S. Pasadena, Calif.
—*Circle 453

Flexible Coupling

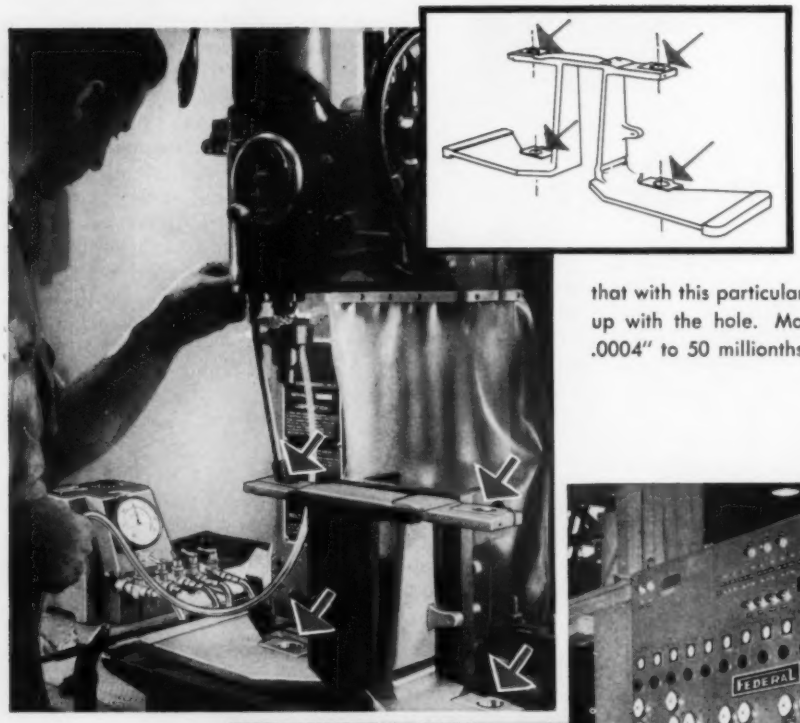
Item 454—

Capable of handling angular misalignment, parallel misalignment and end float, flexible coupling cushions shock loads and diminishes torsional vibration, protecting driver and driven machine. Coupling consists of flexible tire with synthetic tension members bonded together in rubber, clamped between two hubs mounted on the shafts to be coupled. The flexible member is held between the flanges and clamp rings of the hubs.

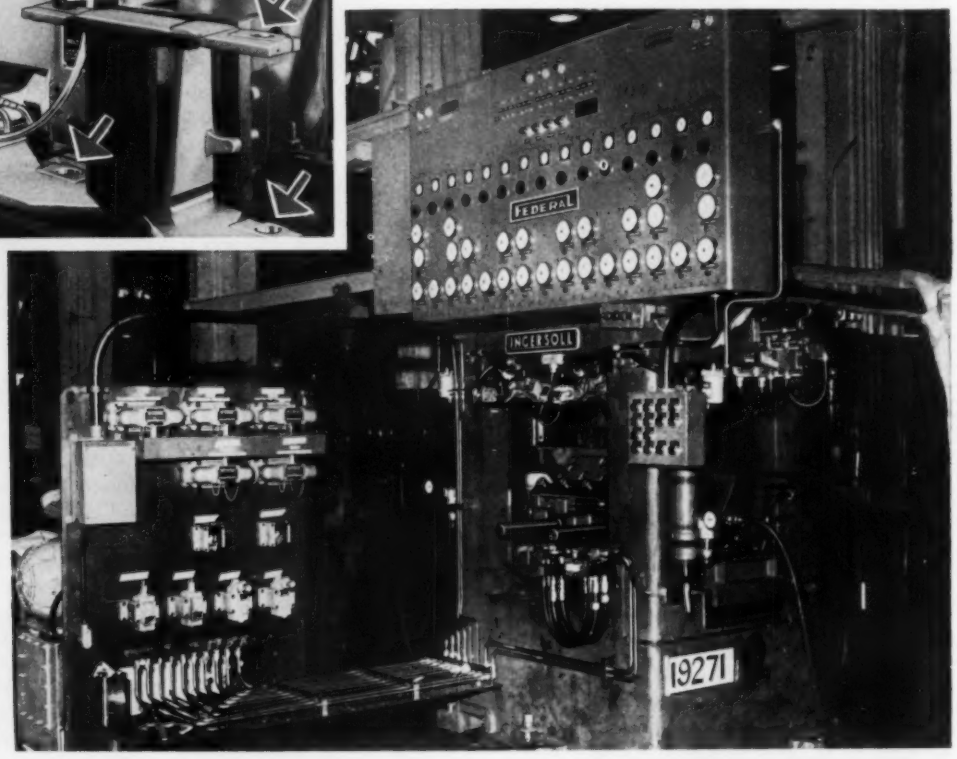
The tire has a transverse split molded into it, allowing easy installation and replacement without moving driver or machine. Unit can accommodate angular misalignment up to four degrees, parallel misalignment up to ⅛-inch and

*For Inquiry Card, see page 17

THEY GAGE THESE



This application at the Arrow Tool Company, Inc., illustrates the adaptability of the Dimensionair. Here it is equipped with a 5-way manifold to which different gaging units are attached ready for other jobs. On this job a Model A-1250 Adjustable Bore Gage is used to inspect 4 holes. Note that with this particular gage the handle does not have to line up with the hole. Many other jobs, having tolerances from .0004" to 50 millionths, are inspected by this Dimensionair.



Federal air-electric gaging and classifying equipment was used in this gaging station on an engine block transfer line. Two diameters in each of five crankshaft bores and two each in five camshaft bores are measured — twenty holes in all. After automatic assembly, oil holes in the five bearing liners are checked for alignment with the holes in the camshaft bores. All conditions are checked simultaneously. Signal lights indicate all dimensional conditions. Unsatisfactory blocks are automatically rejected. Cycle time is well within production cycle time. Ingersoll Milling Machine Company supplied the handling and positioning units.

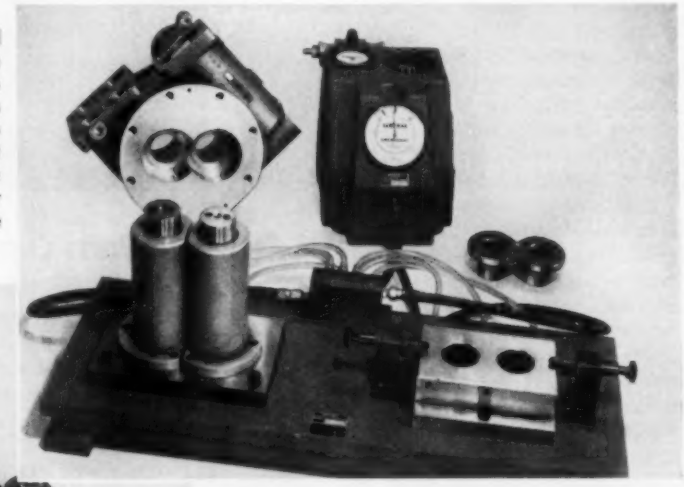
JOBS BETTER

with the DIMENSIONAIR

The increased complexity of more and more of today's gaging requirements calls for the utmost in dependable accuracy. So many times the accuracy of one dimension is dependent upon the accuracy of another. Automation, too, brings in another set of complications where misbehavior of the gaging process can upset your whole schedule.

The dependable no-drift accuracy of the Dimensionair is of the utmost advantage in such cases. Its reliability keeps quality up and keeps production rolling. Even on the simpler jobs the dependable no-drift accuracy and the foolproof operation of the Dimensionair are definitely appreciated. Call on us if you want to do a better gaging job. See our address below.

Two differential type Dimensionairs are used on this precision assembly. The first step is shown at right. Parallel bores in a gear-type fuel pump housing are located on the twin gaging plugs and the bushings that are to be pressed into these bores are placed in the twin ring gage at the right. The Dimensionair shows whether the flange flats on the bushings will have the proper clearance when bushings are assembled in the housing.



A second gage is used for the next step. After the bushings are inserted in the housing, they are located on the left hand pair of gage plugs. Then, a different set of bushings for the cover plate is placed on the right hand plugs. The single dial on this gage shows whether the center distances in the two pairs of bushings are the same within a tolerance of ±.0005". If the first two cover plate bushings measured do not meet this standard, others can be tried until a pair is found that does. Proper alignment of these bearing surfaces is assured at final assembly.

FEDERAL PRODUCTS CORPORATION • 7399 EDDY STREET, PROVIDENCE 1, R. I.

Ask **FEDERAL** *First*

FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging

end float up to 5/16-inch. Units are available in capacities up to 600 hp at 90 rpm. **Dodge Mfg. Corp.,** Mishawaka, Ind.

—*Circle 454

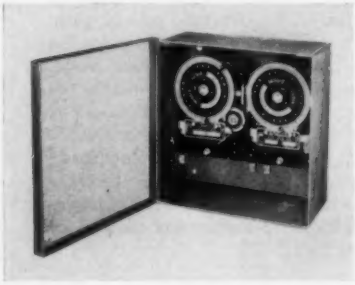
Chart Recorder

Item 455—

Suitable for plant and field applications, self-balancing strip-chart recorder records within a limit of error of 1 per cent and provides full scale balancing time of one second. Servo-balance potentiometer method results in stability, sensitivity and ruggedness.

Designed for panel, rack or portable use, Model G-11 has a unitized measuring circuit. Other features include hermetically sealed plug-in chopper, continuous reference system, chart speed shifter and single or dual chart motors. Unit includes reference mercury cell, pen, pen cleaner, chart roll, and ink supply. **Varian Associates Instrument Div.,** 611 Hansen Way, Palo Alto, Calif.

—*Circle 455



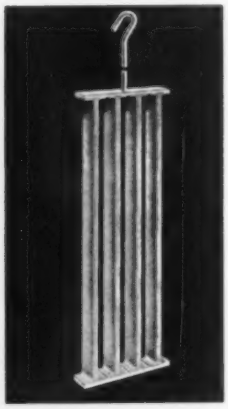
Time Switch

Item 456—

Suitable for use in commercial buildings, office buildings, factories and institutions, unit is capable of automatic control of low-voltage lighting relays and mechanically-held magnetic contactors. A 24-hour timing dial automatically provides a 3 to 5 second *on* pulse and *off* pulse. Four timing dials are available; 24-hour; skip-a-day; astronomic; and astronomic-skip-a-day combination.

Time switch can control many lighting circuits through one master central control or any remote switching point. **Tork Time Controls Inc.,** Mt. Vernon, N. Y.

—*Circle 456



Conveyor Parts-Carrier

Item 457—

Magnetic unit for carrying parts along on over-head conveyors. Device eliminates the need for hooks, hangers and the fabrication of special conveyor devices. Parts are placed on the permanent magnet tines of the unit and are securely held for conveying through such processes as cleaning, rinsing, painting and drying.

Magnetool Div., Multifinish Mfg. Co., 26341 W. 8 Mile Rd., Detroit 19, Mich.

—*Circle 457

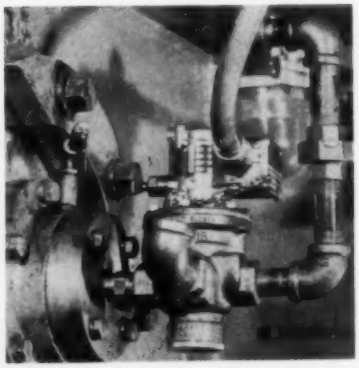
Transformer Kit

Item 458—

Outfit designed for persons engaged in developing computing devices and automatic systems for measurement and control of motion, dimension, flow, pressure, temperature, and weight. Tool facilitates the conversion of linear displacement to an electrical signal.

Differential transformer kit consists of seven complete transformers having a linear range from ± 0.01 to ± 2.5 inches, a flexure plate and clamp for positioning coils, and a demodulator which converts ac output of the differential transformer to dc voltage. Transducer handbook describing the theory, development and use of differential transformers is included. Complete data about the differential transformers in the kit is given in curves and tabular form. **Automatic Temperature Control Co.,** 5200 Pulaski Ave., Philadelphia 44, Pa.

—*Circle 458



Control Valves

Item 459—

Designed for brake, clutch and other high speed applications, control valves provide split-second response. Shorter machine cycle time, more accurate cuts for high speed cut-offs and faster machine set-up result from the faster response. Standard solenoid pilot operates the air cushioned poppet.

Valves are offered in 2 and 3-way types, NO or NC, with integral pilots for remote pilot operation. Sizes range from ¼ to 1-inch NPT for working pressures of 10 to 200 psi. Solenoid pilot coils for ac or dc of any voltage are available.

Optional features include man-

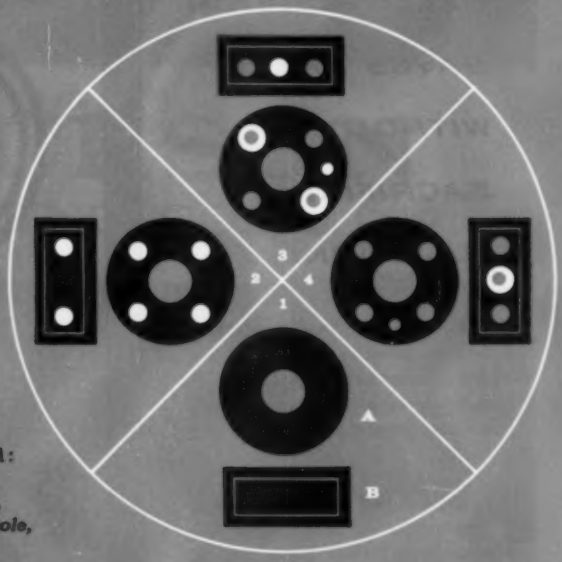
*For Inquiry Card, see page 17

Natco Naturals

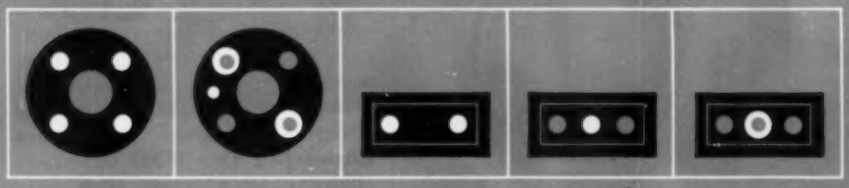
Cost-Cutting Ways
You Can Use
Standard Multi-Spindle Natcos

Any time your parts require machining *more than one hole*–drill, bore, face or tap–it may well be a "Natco Natural." Your standard Natco will produce substantial savings in a surprising number of situations, *even in small job-shop lots!* Call in your nearby Natco field engineer; he'll tell you in short order whether you've got a "Natco Natural" there.

Multiple Drilling Operations on Two Part-faces

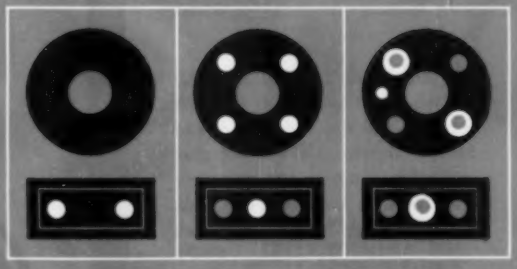


130 parts per hour—4-position rotary table. POSITION #1: *Unload finished part, transfer half-finished part, load new part.* POSITION #2: *Drill 4 holes, Face A. Drill and countersink 2 holes, Face B.* POSITION #3: *Drill 1 hole, ream 2 holes, Face A. Drill 1 hole, Face B.* POSITION #4: *Trepan 1 hole, Face B.*

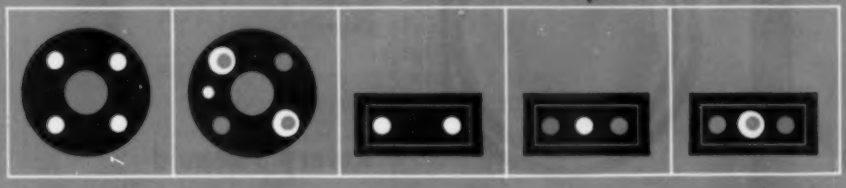


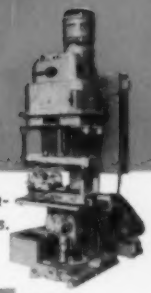
65 parts per hour—stationary fixture *with 5 work locations. Operator transfers parts after each stroke. One part completed per stroke.*

40 parts per hour—straight-line indexing. *After every 3 strokes, operator unloads finished part, transfers half-finished part and loads fresh part.*



23 parts per hour—tumble-type fixture. *Operator transfers and tumbles fixture from one position to the next. One part completed every five strokes.*





Standard multi-spindle Natcos range from 1 hp, 10-spindle machines to 50 hp machines with up to 72 spindles. Spindles in standard Natcos are driven through universal joints and located by either adjustable arms of bored slip plates.

NATCO

National Automatic Tool Company, Inc.

Richmond, Indiana

Multi-spindle drilling, boring, facing & tapping machines. Special machines for automatic production.

Call Natco Offices in Chicago, Detroit, New York, Buffalo, Boston, Philadelphia, Cleveland, Los Angeles; distributors in other cities.

Circle 705 on Inquiry Card

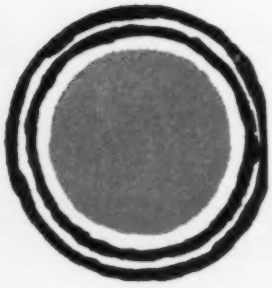
SELECT-O-PUSH SAVES SPACE WITHOUT SACRIFICING FUNCTION!

One unit, the Westinghouse Select-O-Push, combines a pushbutton and selector switch to do the job normally requiring two assemblies. It cuts panel-front space need by half.

When wired with a standard double-pole contact it becomes versatile in limited space, freeing valuable enclosure area.

The same attention to detail built into all Westinghouse controls applies to the Select-O-Push. It functions excellently where moisture threatens. Tight-fitting gaskets, stainless steel shafts, precision milling—all help keep out harmful liquids.

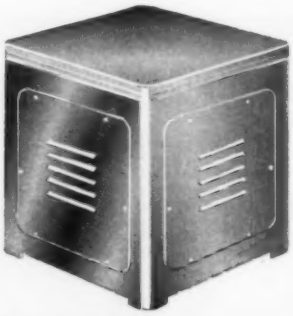
A Guide to Control (B-7022) will tell you more about Oil-Tite* controls. The new 72-page *Push-button Guide* (B-6749) will give you information on the complete line. Write to Westinghouse, Box 868, Pittsburgh 30, Pa. *Trade-Mark J-30254



YOU CAN BE SURE...IF IT'S

Westinghouse

ual over-ride and integral junction box. **Valvair Corp.**, 454 Morgan Ave., Akron 11, Ohio.
—*Circle 459

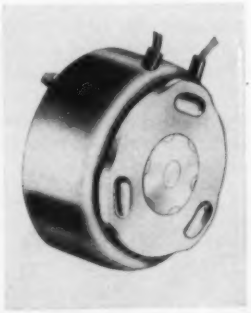


Machine Bases

Item 460—

Standard machine bases save engineering and fabricating time. Bases are made of steel plate ranging from 3/16 to 5/16-inch in thickness. Parts, which are shipped knocked-down, are designed for any size of base from 24 to 48-inches in length or width and from 24 to 54-inches in height. Parts are predrilled so they can be bolted together for quick assembly by welding.

Bases can be re-used by making changes in tooling. **Inter-Lakes Engineering Co.**, 39200 Groesbeck Highway, Mt. Clemens, Mich.
—*Circle 460



Rotary Solenoid

Item 461—

Applicable for high ambient temperatures to 500 F, rotary solenoid can operate with higher wattage inputs to produce higher torques. It can be used in radio-

*For Inquiry Card, see page 17

NEW ERICKSON EXPANDING-COLLETS

The new Erickson Expanding-Collet is the only known commercial expanding arbor that can grip in a hole as small as ⅛ inch. That's because it's a one-piece arbor actuated in the same manner as a reversed collet . . . a collet which grips the workpiece on the *inside surface*. Because of its one-piece design without drawpin, it gives maximum wall thickness and full gripping power equal to that of a collet.

That means you can convert your machine to internal chucking by merely inserting the new Erickson Expanding-Collet. And since it is machined in place on the machine, it gives greatest possible accuracy . . . can be re-machined for new jobs . . . solves the rush-order problem.

Order a stock of new Erickson Expanding-Collets. They'll save your time, your temper and your money.

AA-3561

Write for your free copy of *"Erickson Expanding-Collet"* today. And also request "Catalog K"; you'll find cost-slashing applications for all Erickson holding tools.

APPLICATIONS

LATHES • TURRET LATHES • SCREW MACHINES
SPEED LATHES • AUTOMATIC CHUCKING MACHINES
BURRING MACHINES • MILLING MACHINES • DRILL PRESSES
CUTTER AND CYLINDRICAL GRINDERS • GEAR CUTTERS
INDEXING HEADS • COLLET CHUCKS • ETC.

ERICKSON TOOL COMPANY

2307-9 Hamilton Avenue • Cleveland 14, Ohio

COLLET CHUCKS • FLOATING HOLDERS • TAP CHUCKS • TAP HOLDERS • AIR-OPERATED CHUCKS
EXPANDING MANDRELS • EXPANDING-COLLETS • SPECIAL HOLDING FIXTURES

Circle 707 on Inquiry Card

on the job experience proves it . . .

you get the most
for your money when you buy

MATHEWS CONVEYERS

A system of double-deck live roller conveyers handling tote pans in a modern machine shop. Pans are deflected to the machines off the top deck. Empties return on bottom deck.

Whatever the conveying problem might be—whether it involves the handling of cartons, cases, or bags—Mathews builds the equipment to do the job in the best way. You can be sure of a complete service from planning through installation. You get the benefit of over 50 years of experience in **continuous flow** materials handling, and a product that is guaranteed to stay on the job. That is why we believe you get the most for your money when you buy Mathews Conveyers.

MATHEWS CONVEYER COMPANY

GENERAL OFFICES . . . . . ELLWOOD CITY, PENNSYLVANIA
PACIFIC COAST DIV. . . . MATHEWS CONVEYER COMPANY WEST COAST, SAN CARLOS, CALIFORNIA
CANADIAN DIVISION MATHEWS CONVEYER COMPANY, LTD., PORT HOPE, ONTARIO

MATHEWS

Fifty Years of Leadership in Mechanized Handling

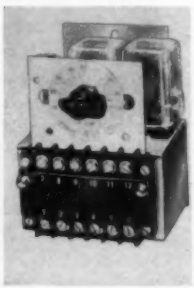
active atmospheres without damage. Magnetic action moves the armature along the solenoid axis. This action is converted into a rotary motion by means of ball bearings on inclined races.

Unit is offered in eight sizes ranging from 1 to 3⅜ inches in diameter. Starting torques for 45 degree stroke range from 0.2 lb-in. to 54 lb-in. **G. H. Leland, Inc.,** 123 Webster St., Dayton 2, Ohio.
—*Circle 461

Hydraulic Cylinders

Item 462—

Capable of actuation on smaller products, non-cushioned hydraulic cylinders are offered in five bore sizes from ½ to 1½-inches. Rated at 3000 psi continuous service, with peaks up to 10,000 psi, cylinders are available in lengths up to 36-inch stroke. Also included in line are telescopic cylinders and cylinders for use in pneumatic service. **Oil-Dyne Inc.,** 2115E W. Marquette Rd., Chicago 36, Ill.
—*Circle 462



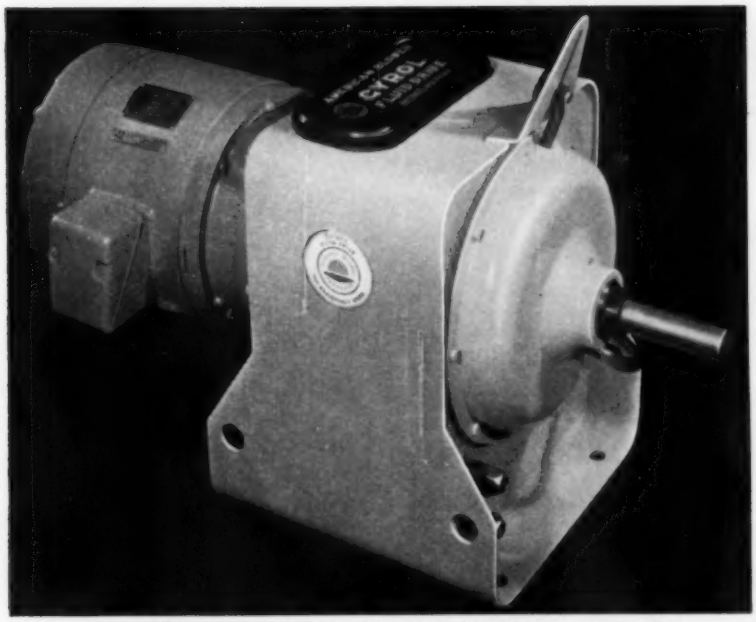
Electronic Timer

Item 463—

Features of Model 120 include: stop-motion control by means of an external control switch that discharges the timing condenser; self-reset timing with several units in sequence by hold-in of load relay; momentary-start with non-repeat, self reset feature; sus-

*For Inquiry Card, see page 17

Why you should include Gýrol® Fluid Drives in your plans for automation



Compact, flange-mounted Type VS, Class 2 Gýrol Fluid Drive — 1 to 25 hp.

For one thing, Gýrol Fluid Drives provide adjustable, *stepless* speed control of driven machinery, using *standard*, constant-speed motors — without complicated electric circuits or starting devices.

Adaptable to remote, manual, or automatic speed control, Gýrol Fluid Drives are compact, self-contained units — requiring only the conventional flexible-coupling connections to the motor and load. They provide complete shock absorption, are easy to install in a variety of arrangements of driving to driven machinery. Why not call our nearest branch for full details today?

Typical Applications

PUMPS, AGITATORS, MIXERS

CONVEYORS, CABLE & ROPE MACHINERY

FANS AND BLOWERS

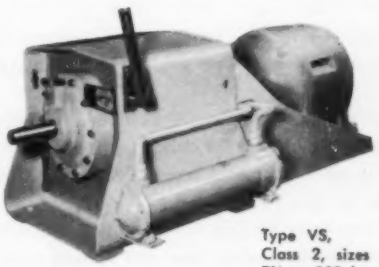
CENTRIFUGAL COMPRESSORS

PAPER AND PRINTING MACHINERY

TEXTILE MACHINERY

Complete range of sizes — 1 hp to 12,000 hp

The Gýrol Fluid Drive line includes a complete range of sizes, from 1 to 12,000 hp. All save power through lower horsepower requirements. A minimum number of wear points cuts maintenance. And, because Gýrol Fluid Drives bring about reduced speeds and pressures, driven equipment lasts longer.



Type VS, Class 2, sizes 7½ to 800 hp.

American Blower products serve industry

- Air Conditioning, Heating, Ventilating Equipment
- Mechanical Draft Equipment
- Industrial Fans and Blowers
- Centrifugal Compressors
- Gýrol Fluid Drives
- Dust Collectors
- Refrigerating Machines

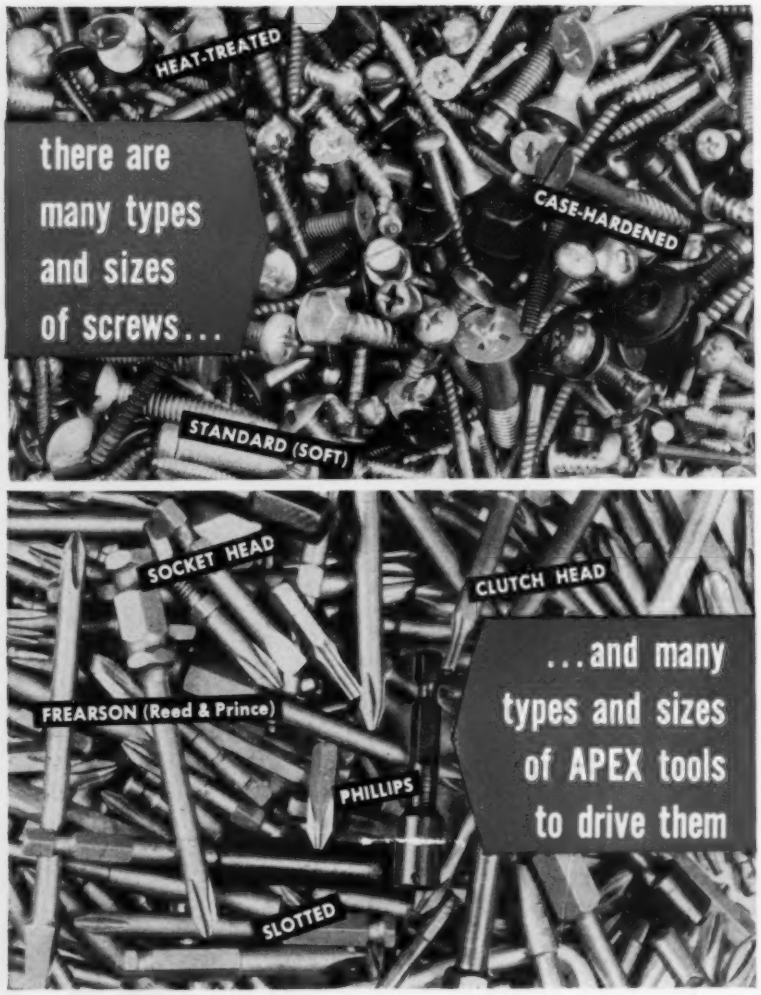
American Blower Division of American-Standard, Detroit 32, Michigan
In Canada: Canadian Sirocco products, Windsor, Ontario

AMERICAN BLOWER

Division of AMERICAN-Standard

QUALITY PROTECTS YOUR INVESTMENT... AMERICAN-Standard QUALITY IS AVAILABLE AT NO EXTRA COST

Circle 709 on Inquiry Card



APEX—authority on fastening—offers the most complete range of screwdriving tools, and every one is designed for a specific screwdriving application.

For example, Apex insert bits are available in 18 different heat treatments. Whether you're driving soft screws, heat-treated screws, or case-hardened sheet metal screws, you can select an Apex insert bit exactly suited to your requirements.

If you drive Phillips, Frearson (Reed & Prince), Slotted, Clutch Head or Socket Head screws, you can reduce your fastening costs with Apex Screwdriving Tools. For complete information, write, on your company letterhead please, for Catalog 25 (Magnetic Tools) or Catalog 21 (Standard Tools).

APEX THE APEX MACHINE & TOOL COMPANY
1036 S. Patterson Blvd. • Dayton 2, Ohio

ATLANTA • BALTIMORE • BATON ROUGE • BIRMINGHAM • BUFFALO • CHARLESTON
CHICAGO • CLEVELAND • COLUMBUS (Newark) • DALLAS • DAVENPORT • DENVER
DETROIT • HOUSTON • INDIANAPOLIS • KANSAS CITY • LOS ANGELES • LOUISVILLE
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PHILADELPHIA • PITTSBURGH • PROVIDENCE • ROCKFORD • ST. LOUIS • SEATTLE
SHREVEPORT • SOUTH BEND • SYRACUSE • WICHITA

Circle 710 on Inquiry Card

tained starting with immediate reset on opening of start switch, emergency timing-out in middle of time cycle to permit delay circuit condition, adjustable timing between fixed pulses, and repeat-cycle timing.

Load contacts are isolated from timer and line circuits. Two sets of SPDT 8 amp contacts are included; one set to operate at start, and one set at end of time delay. **Farmer Electric Products Co. Inc.**, 2300 Washington St., Newton Lower Falls, Mass.

—*Circle 463

Solenoid Valve

Item 464—

Unit is bubble-tight at 5000 psi working pressure, Type SBTDW solenoid valve with new Teflon seat is suited to applications where high pressure is combined with relatively little flow. The small, direct lift, angle type unit is machined from type 316 stainless steel bar stock. The direct lift action provides instantaneous opening and closing with viscous fluids. Pipe sizes are ⅛ and ¼-inch with 1/16, 3/32, ⅛ or 3/16-inch port sizes. **Atkomatic Valve Co. Inc.**, 545 W. Abbott St., Indianapolis 25, Ind.

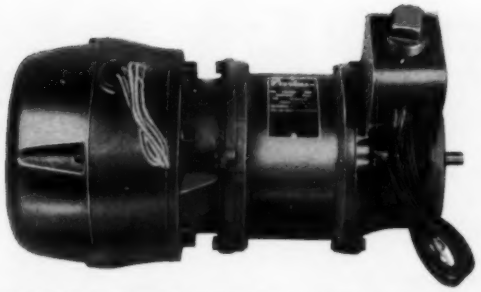
—*Circle 464

Elbow Fittings

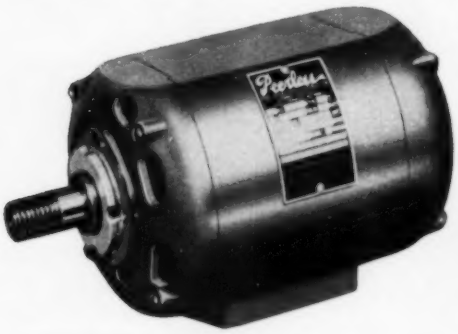
Item 465—

Designed for use with company's medium and high pressure hose, elbow fittings are available in 45

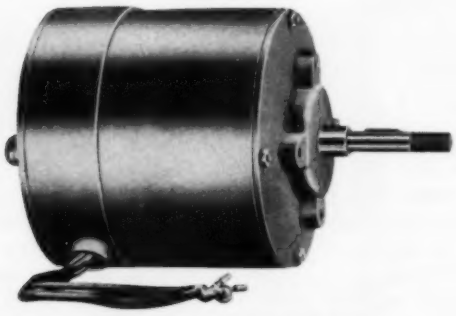
*For Inquiry Card, see page 17



EXPLOSION-PROOF TORQUE MOTOR WITH BRAKE



COMPACT DESIGN RADIAL SAW MOTOR



NAVY MOTOR—SPRAY-TIGHT

SPECIAL MOUNTED VERTICAL MOTOR

If stock motors cut machine efficiency see Peerless.

Peerless builds a complete line of general purpose motors as well as hundreds of specials designed to meet specific needs. Our engineers have wide experience in applications of all types, and specialize in solving motor problems for design engineers who require unusual mountings or unusual construction to achieve maximum machine efficiency. Consult your nearby Peerless representative or write directly to us about any motor problem. We'll work with you to develop the one motor that powers your equipment best. Write for Bulletin SDA-155 now.

Single phase
½ thru 7½ HP

Polyphase
½ thru 30 HP

ELECTRIC MOTOR DIVISION
THE Peerless-Electric® COMPANY
FANS • BLOWERS • MOTORS • ELECTRONIC EQUIPMENT
1512 W. MARKET ST. • WARREN, OHIO

EACH PART OF A LOVEJOY UNIVERSAL JOINT IS PRECISION GROUND AND PERFECTLY FITTED

Lovejoy Universal Joints are precision-built for tough service . . . are light-weight, quick-acting to give sensitive response and smooth performance.

Compact construction makes them ideal for close quarter operation. Simplicity of design and absence of complicated parts assure dependability, long life and negligible maintenance.

Lovejoy's full line of standard sizes can provide you with the universal joint that is *just right* for any slow speed application. Special units can be made to individual specifications on request.

Standard sizes range from fractional to 207 hp., diameters ½" to 4", bores ¼" to 2", lengths 2" to 10⅝".

Contact Lovejoy now for complete information. Request bulletin.

LOVEJOY FLEXIBLE COUPLING CO.

4806 W. LAKE STREET • CHICAGO 44, ILLINOIS

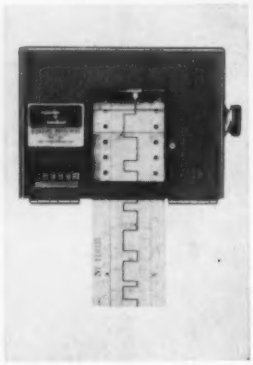
Mfrs. of Flexible Couplings, Variable Speed Pulleys and Transmissions, Motor Bases and Universal Joints.

Circle 712 on Inquiry Card

and 90 degree configurations. They are applicable on any hydraulic, fuel, air, water, or lubricating oil installation requiring a short radius connection. Swivel fittings tighten without twisting the assembly, and assemblies with double elbow fittings can be angled to the positioning required by the installation.

Lower number of joints and fittings, less flow restriction, and reusability of the fittings are features of device. Fittings are fabricated from formed tubing and have swivel nut ends. Mating adapters are also offered for straight gasket seal and pipe threads. **Aeroquip Corp.**, Jackson, Mich.

—*Circle 465



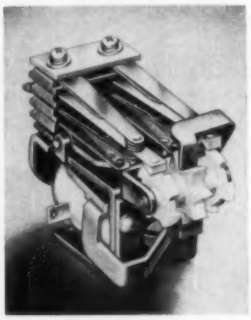
Recording Unit

Item 466—

Instrument accumulates data on the operation of machines, processes or systems. Chronologically marked tape from a 250 ft chart-roll continuously moves through the instrument recording the time and length of every *on* or *off* period of the equipment. Time and frequency of machine, process or system is impressed on the tape for a permanent record. Any deviation from normal operation is recorded. An access window can be lifted so that notations may be made on the chart.

Time totalizer unit computes and registers total operations time. It can register in hours and tenths of hours, or in minutes and tenths of minutes. A counting device can be furnished in place of the totalizer for determining the number of pieces produced or processed by machines such as punch presses, drill presses, stamping machines, or injection molding equipment. Speed of the recording unit can be from 1-inch per hour to 10-inches per minute. **Standard Instrument Corp.**, 657 Broadway, New York 12, N. Y.

—*Circle 466



Sequence Relays

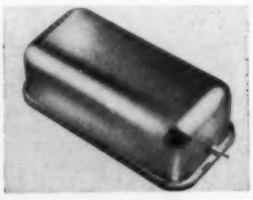
Item 467—

Unit offers a variety of DPST and DPDT contact arrangements which can be set to open, close or transfer in any desired sequence. Model 211 is suitable wherever a predetermined cycle of operation is needed.

Double cam movement permits contacts to be adjusted to operate when the coil is de-energized. The Nylon cam rotates a half step when the coil is energized and completes the step when de-energized.

Continuous-duty coils in ratings up to 115v dc or 230v ac can be supplied. Power consumption is 5 to 6w dc or 10 to 12 va ac. **Struthers-Dunn Inc.**, Pitman, N. J.

—*Circle 467



Ultrasonic Transducer

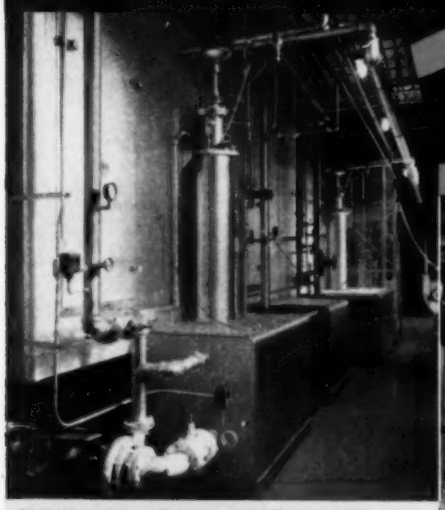
Item 468—

Suitable for cleaning, degreasing, and processing, ultrasonic transducer uses piezoelectric ceramics. Model UT-2-42 is designed for modular assembly to cover large areas

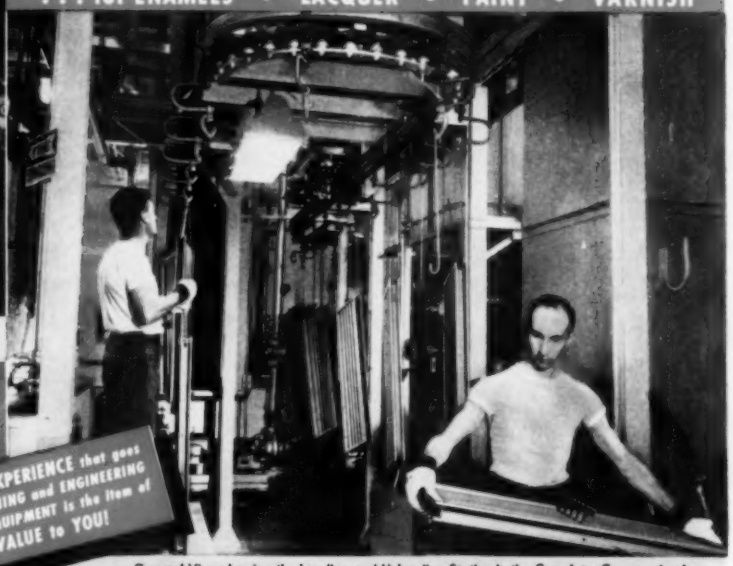
*For Inquiry Card, see page 17

COMPLETE *Finishing* SYSTEMS

. . . for ENAMELS • LACQUER • PAINT • VARNISH

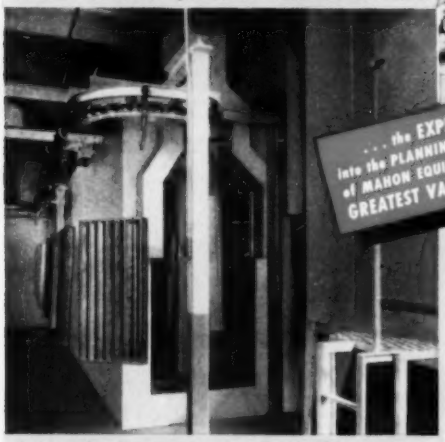


Partial View of Mahon Five-Stage Metal Cleaning and Bonderizing Machine in the Airolite System. Note Patented Fire-Jet Heaters.



. . . the EXPERIENCE that goes into the PLANNING and ENGINEERING of MAHON EQUIPMENT is the item of GREATEST VALUE to YOU!

General View showing the Loading and Unloading Station in the Complete, Conveyorized Mahon Finishing System recently installed in the Airolite Company's Plant, Marietta, Ohio.



Exit Opening in the Mahon Dry-Off Oven. This Oven is Combined with the Paint Baking Oven and Built as One Direct Gas-Fired Unit.

In the view above you see an Oven Heating Unit and a Control Cabinet which Houses Temperature Recorder and Safety Devices. Ventilated Solvent Vapor Chamber appears at left.

High Quality, Durable Finish on AIROLITE LOUVERS is Produced in a COMPLETE, MODERN MAHON SYSTEM!

The Airolite Company, Marietta, Ohio, manufacturers of high quality fixed and adjustable Louvers of all types, and numerous other metal products, have recently modernized production facilities which now include a complete, new Mahon Finishing System specially designed to accommodate all products presently in production as well as several items planned for the future. The new Mahon Finishing System in the Airolite plant includes a five-stage Metal Cleaning and Bonderizing Machine, Dry-Off Oven, Flow Coating Machine with a Ventilated Solvent Vapor Chamber, and a Paint Baking Oven . . . processing is continuous and automatic from conveyor loading to unloading. This is one of thousands of Mahon finishing systems that have been specially designed and installed in each case to meet the specific requirements of the manufacturer. If you have a finishing problem, or are contemplating new finishing equipment, you, too, will want to discuss methods, equipment requirements and possible production layouts with Mahon engineers . . . you'll find them better qualified to advise you, and better qualified to do the all-important planning, engineering and coordinating of equipment to produce the finest finish at minimum cost. See Sweet's Plant Engineering File for information, or write for Catalog A-657.

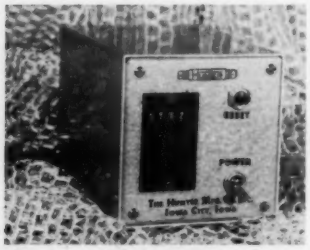
THE R. C. MAHON COMPANY • Detroit 34, Michigan

SALES-ENGINEERING OFFICES in DETROIT, NEW YORK and CHICAGO

Engineers and Manufacturers of Complete Finishing Systems — including Metal Cleaning, Pickling and Rust Proofing Equipment, Hydro-Filter Spray Booths, Dip and Flow Coaters, Filtered Air Supply Systems, Drying and Baking Ovens, Cooling Tunnels, Heat Treating and Quenching Equipment for *Aluminum* and Magnesium, and other Units of Special Production Equipment.

MAHON

with nonfocusing and uniform sound field. It has a high conversion efficiency and its frequency is suitable for various types of processing. Unit is immersible in organic solvents, aqueous solutions of normal detergents, mild alkalis or acids. **Gulton Industries Inc.**, 212 Durham Ave., Metuchen, N. J.
—*Circle 468

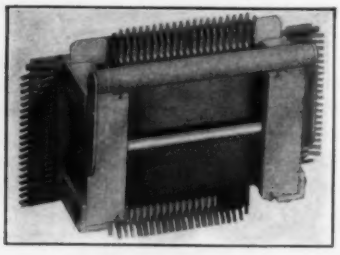


High Speed Counter

Item 469—

Applicable for items traveling along a production or inspection line, electrically operated counter has production rate up to 20 cps.

Model 140 has a four digit counter ranging from 1 to 9 999 and a pushbutton reset. A circuit leading to a remote counting switch or other closing device can be connected to two terminal block contacts on the rear face of the unit. Rated for 110v, 60 cycle ac, instrument is offered in two different counting speed ranges. **Hunter Mfg. Co.**, 108 So. Linn St., Iowa City, Iowa
—*Circle 469

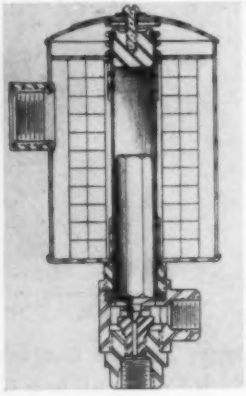


Punched Card Reader

Item 470—

Circuit switching device provides a substitute for patch cord panel systems. A molded block with 400 floating contacts passes from one face to the other. The contacts make connections between groups of conductors on one of the printed wire boards to other groups on the other, except where a card interposes its insulation. Perforations in an ordinary 3 by 5-inch card permit connections to be made where wanted. Connections are easily changed.

In operation, a card is inserted in the slot at the top and the lever closed. Unit is designed not to operate unless card is inserted in the correct position, and closure cannot be made while a card is missing. All circuits are disconnected before the contacts are opened. **Cinch Mfg. Corp.**, 1026 S. Homan Ave., Chicago 24, Ill.
—*Circle 470



Solenoid Valve

Item 471—

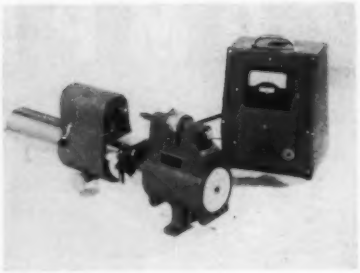
Suitable for corrosive gases and liquids, Type GX solenoid valve comes in ⅛, ¼ and ⅜-inch pipe sizes with ports from 1/16 to ¼-inch. The medium flowing through the valves comes in contact only with stainless steel and teflon.

Waterproof coils, hermetically sealed in molded thermoplastic casing, are used for temperatures to 250F. Silicone insulated coils are used for higher temperatures. **J. D. Gould Co.**, 4707 Massachusetts Ave., Indianapolis 18, Ind.
—*Circle 471

Electric Micrometer

Item 472—

Used as a comparator for the checking of reamers, end mills, plug gages and for similar applications, Electrolimit Supermicrometer is



also suitable alongside machines doing final grinding and lapping, and in final inspection. Initial settings are made with Hoke precision gage blocks or master plug gages of known accuracy. The meter is set on zero by means of the masters, and deviations in the size of the product are read directly to 0.00002-inch on the dial. A zero setting is also provided when the unit is used in the conventional manner. **Pratt & Whitney Co. Inc.**, Charter Oak Blvd., W. Hartford, Conn.
—*Circle 472

Machine Load Ammeter

Item 473—

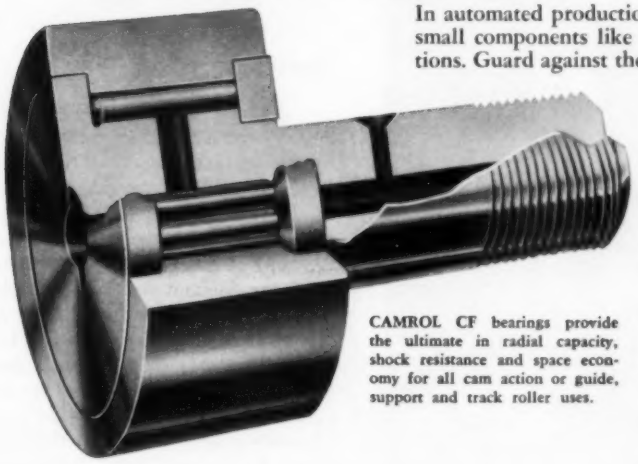
Designed for use on machine tools powered with dc, where tool wear indications and power readings are desired, Model L-122 DC provides a variable range calibration. A change in the amperage range of the dc meter is made by hand adjustment of the calibrator. Adjustability feature of the meter allows use of the unit on several types of machines or for different job applications on same machine.

Features of the instrument include cushioned sapphire jewels to absorb vibration and shock; calibrated dial in per cent of load with graduated colors for easy reading, and instrument accuracy under full or partial loads. It is available in standard ranges from 9 to 45 and 25 to 150 amp. **Futurmill Inc.**, 6360 Highland Rd., Pontiac, Mich.
—*Circle 473

*For Inquiry Card, see page 17

AUTOMATION TIPS by McGill

CAMROL® bearings ideally suited to anti-friction requirements of automated machinery

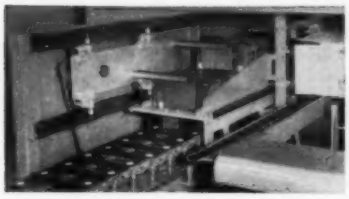


CAMROL CF bearings provide the ultimate in radial capacity, shock resistance and space economy for all cam action or guide, support and track roller uses.

In automated production, even the inefficiency and faulty operation of small components like a cam follower unit can cause costly interruptions. Guard against these failures by specifying CAMROL cam followers. Their quality insures dependability. Their design simplifies lubrication, easily accommodates critical loads and provides low starting and running friction.

Over 20 years of engineering development has gone into the McGill bearing — the first commercial full-type roller bearing cam follower. McGill has employed the advantages of these years of application experience to improve the design and build performance extras into the CAMROL CF, CYR and sealed SCF and SCYR series bearings. All are available in a wide range of standard sizes.

The applications cited below are just a few of the many instances where CAMROL bearings are adding to the dependability of automated machinery.

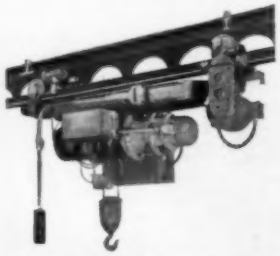


Camrol CF bearings cut power requirements on J. L. Ferguson Co. packaging machines

Used as load-carrying cam followers and as guide rollers in PACKOMATIC packaging machinery, McGill CAMROL CF bearings have brought several desirable advantages to J. L. Ferguson Company in the eight years this firm has relied on CAMROL bearings.

The CAMROL CF bearings eliminate wear by reducing friction. This reduces power requirements and smooths the operation of these machines. The CF bearings are standard, cost less and are more easily applied than previous assemblies.

For trouble-free operation, up to 50 bearings per machine are now used by this company.

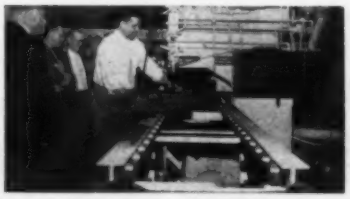


Cleveland Tram Rail guides motor heads on McGILL Camrol Bearings

Motor-driven electric hoist carriers made by the Cleveland Tramrail Division of the Cleveland Crane and Engineering Company, incorporate McGill CAMROL Cam Follower bearings as side guide rollers for the motor head.

Replacing spring loaded friction type bolt or roller units, the CAMROL cam followers provide dependable, free running operation of the carrier assembly and provide simplicity of mounting and lubrication with trouble-free performance.

Bearing performance has been most satisfactory through almost six years of use.



Camrol CF bearings provide friction-free track rollers for automatic mold blower

McGill CAMROL CF rollers are used as track rollers to form a mold conveyor in the Beardsley & Piper MBS-20 Mold Blower. The CAMROL CF bearings replaced built up friction rollers in this application. Although the duty here is rather light and the speeds slow, the cam follower bearing provides less starting and running friction. This helps speed the even flow of work from the machine, which must be fast and automatic. The compact unit, with integral stud, simplifies assembly and lubrication. Availability of a standard bearing is more convenient and less costly.

SEND FOR CATALOG 52-A

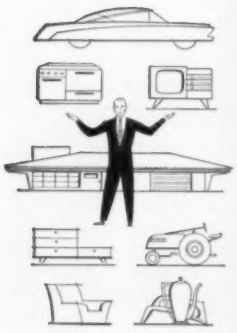
Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 401 N. LAFAYETTE ST., VALPARAISO, INDIANA

Part of extensive Logan System in brass mill. Roller Conveyor loop serves as coil storage ahead of pickler served by Downender in foreground. Coils are fed to storage line by Vertical Reciprocating Conveyor at right.
DEMING CO.
DETROIT BRASS & MAL'BLE
DETROIT TRANSMISSION DIV.
DE VILBISS CO.
DEVOE & RAYNOLDS CO.
DODGE MOTORS DIV.
JOHN DOUGLASS CO.
E. I. DuPONT DE NEMOURS
DOW CHEMICAL CO.
D
EASTMAN KODAK CO.
ELECTRIC AUTO-LITE CO.
ELECTRIC STEEL CASTINGS
ELECTROLUX CORP.
EMERSON ELECTRIC
ESSO STANDARD OIL
EUREKA MFG. CO.
EVEREDY CO.
E
FAIRBANKS-MORSE
FARNSWORTH RADIO & TV
FIRESTONE TIRE & RUB.
FISHER BODY CORP.
FLEISCHMANN CO.
FLINTKOTE CO.
FORD MOTOR CO.
FRANKFORT DISTILLERY
(cont.)
F
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

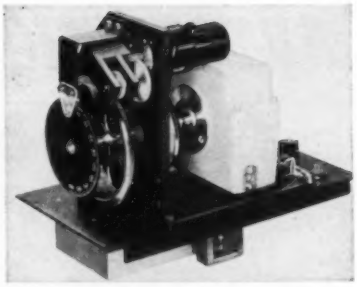
The LEADERS use Logan



"Staying out in front" often is just as difficult as getting there in the first place. That is one of the reasons why America's leading industries depend on Logan Conveyors as an integral part of their productive processes. Speeding output, enlarging capacity, conserving manpower, and decreasing labor turnover are major Logan functions which you, too, can use to advantage. Write for nearest engineer or for further information.

LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

Logan Conveyors



Servo Digitizer

Item 474—

Applicable to ground and flight instrumentation, industrial data logging, analog translation to feed digital computers, or as an input to a card or tape system, Model SL-1004 is designed to digitize into a binary-decimal code any physical quantity that is available as a 400 cps voltage in phase with the line.

A miniaturized, high gain transistor-magnetic servo amplifier and power supply is included in unit. Encoder shaft is driven ±170 degrees from zero. Full scale corresponds to 10v rms 400 cps, in phase with the line. Static error is 0.15 per cent of full scale, and fast rates can be followed with a velocity error constant of 1/500 seconds. **Industrial Control Co.**, 805 Albin Ave., Lindenhurst, L. I., N. Y.

—*Circle 474

Air Valve

—*Circle 475

Independent body and solenoid which can be singly removed from the base without disturbing the other is feature of air valve. An integral conduit box for greater compactness and a solenoid with shock-resistant mountings are provided.

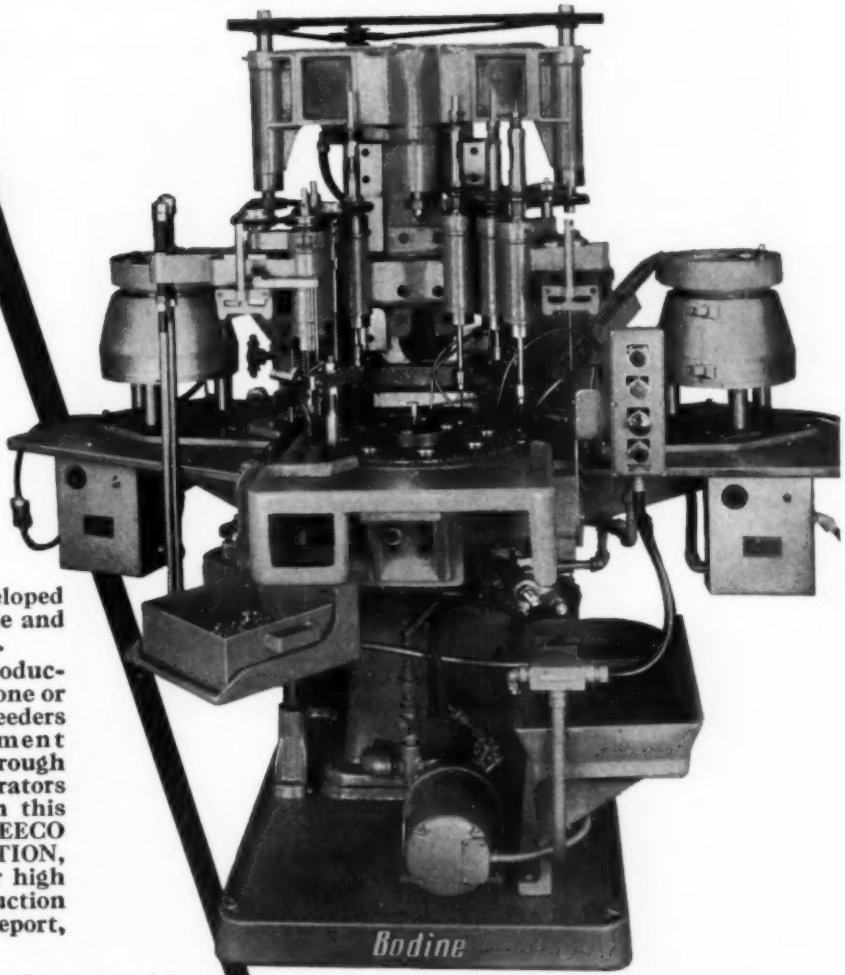
Valve is available in ⅜-inch single-solenoid, double-solenoid and 3-way models. **Mechanical Air Controls**, 10030 Capital, Oak Park, Detroit 37, Mich.

Item 475—

*For Inquiry Card, see page 17

Production Equipment Produces

MORE with PEECO



Vibratory Parts Feeders play an ever increasing important roll in the industrial drama "to produce more for less." PEECO's leadership in the field of vibratory feeders and their helpfulness to industry in developed techniques that save time and money, are unchallenged.

Just as in the case of production lines, the placing of one or more PEECO developed feeders on production equipment effects great savings through the elimination of operators and/or operator time. In this field now being served by PEECO is the BODINE CORPORATION, the established name for high volume automatic production and assembly, of Bridgeport, Connecticut.

If you want to produce more, send for bulletin #563 and ask for the name of the PEECO representative in your area.

DEVELOPED PEECO FEEDERS NOW included on production equipment by Bodine

This standard Bodine Model 4120, dial type, automatic tapping and screw inserting machine, automatically hopper feeds, transfers and drives two screws at a time and automatically captivates them. This machine normally operates to produce 2750 pieces per 50 minute hour.

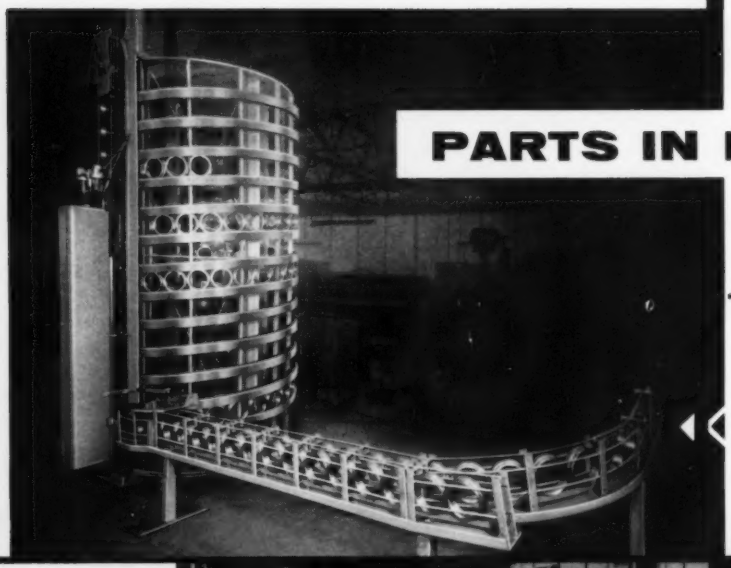
THE WORLD'S LARGEST

EXCLUSIVE MANUFACTURER

OF VIBRATORY PARTS FEEDERS

Peeco PERRY EQUIPMENT & ENGINEERING CO.

ERIE, PA. • • • DIVISION OF AUTOMATION DEVICES, INC.

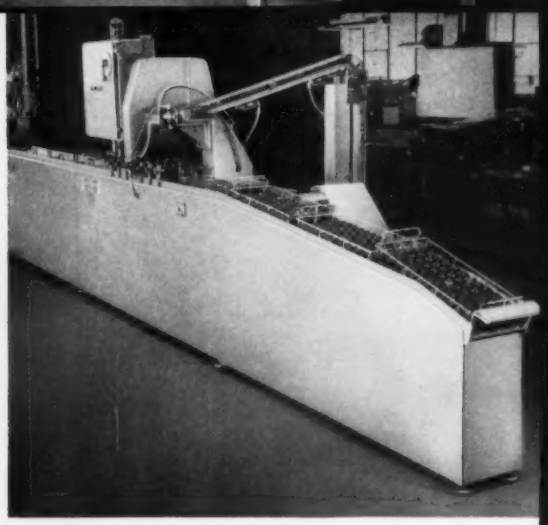


For automating

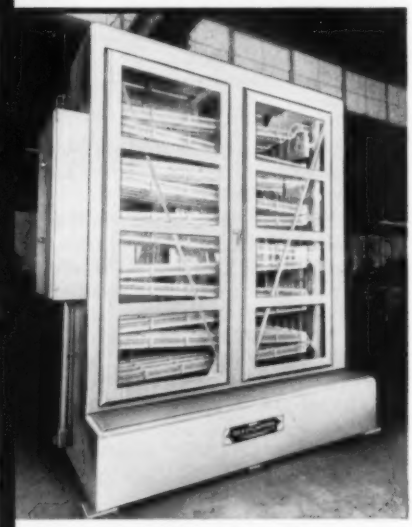
PARTS IN PROCESS...

...with { *demand control*
selective feeding
active storage
positive movement

Gear-O-Mation's rotary storage units for parts that can roll. Pneumatically loaded double threads (retaining tracks) store parts for true "as-required dispensing". Custom built for high capacity (Bulletin GO-567).



Gear-O-Mation's high speed equipment for the automatic "basketing" of parts removes a slow-down point of processing. Assembled from standard components, the units are custom-tailored—this one loads center-bored pinions at 3000 per hour (Bulletin No. GO-568).



Gear-O-Mation's process stabilizing unit—a parts bank to insure production continuity. Recently developed for use between operations, the equipment forms an integrated "demand feeding" system. It will check, store and feed from one to more than 5000 cylindrical parts depending on size (Bulletin No. GO-561).

Imaginatively engineered equipment, functionally designed to extend the scope and application of automated production systems, is now in manufacture at Gear-O-Mation. Not just work-handling or transfer units, but packaged units that offer positive control at any point installed. Gear-O-Mation also manufactures part washers, size classifiers, machine loaders and unloaders, elevators, and other equipment—for semi- or full automatism in large or small plants. Write us for details.

GEAR-O-MATION
DIVISION OF MICHIGAN TOOL COMPANY
7171 E. McNICHOLS RD. • DETROIT 12, MICH.

catalogs and literature

Latest automation information. For copies use card page 17.

496. Tape Instrumentation

Ampex Corp. 934 *Charter St., Redwood City, Calif.*—16 *page booklet*—Magnetic tape instrumentation applicable to data acquisition, data storage and transfer, time delay and programing is discussed in booklet. Tape techniques, systems, and a glossary of terms are also covered.—*Circle 496.

497. Mill Type Cylinders

Hydraulic Power Equipment Co., 210 *Columbiana Rd., Box* 126, *N. Lima, Ohio*—13 *page booklet*—Specifications and dimensions for air and hydraulic non-rotating cylinders and hydraulic rotating cylinders are given in Catalog C-757. Illustrations of hydraulic power units are included.—*Circle 497.

498. Weld Fasteners

Ohio Nut and Bolt Co., 33 *First Ave., Berea, Ohio*—40 *page handbook*—Metal fasteners that can be manually or automatically fed and attached at high speed is subject of Catalog 58. Data and illustrations on the application of different types of nuts, screws, pins and other parts by resistance welding are included.—*Circle 498.

499. Steels for Industry

Crucible Steel Co. of America, Box 1558, *Pittsburgh* 30, *Pa.*—232-*page handbook*—Divided into categories of special purpose steels, including tool, stainless, alloy and cast types, comprehensive Product & Warehouse Catalog describes over 700 products. Estimating, conversion and weight tables are given—*Circle 499.

500. Pressure Gages

Helicoid Gage Div., American Chain & Cable Co. Inc., Bridgeport 2, *Conn.*—28 *page handbook*—Bourdon tube type gages which use no gears in their movements are described in Catalog G-52. Specifications of available gages are given, case and dial designs illustrated, and gage accessories noted.—*Circle 500.

501. Electric Motors

Baldor Electric Co., 4353 *Duncan Ave., St. Louis* 10, *Mo.*—36 *page catalog*—Specifications and dimensions for line of ac and dc motors, adjustable speed systems, grinders and battery chargers are given in catalog. Types described include explosion proof and fan duty models.—*Circle 501.

502. Wire Cloth Products

Cambridge Wire Cloth Co., Cambridge, Md.—94 *page handbook*—Line of industrial wire cloth, screens, and wire cloth products is described. A section on woven wire conveyor belts and their application to metalworking, glass and ceramics, and food processing is included.—*Circle 502.

503. Quick Change Presses

Danly Machine Specialties, Inc., 2100 *S. Laramie Ave., Chicago* 50, *Ill.*—4 *page pamphlet*—Economy of small-lot production runs with quick die change presses is discussed. Advantages of the quick change machines and steps in changing dies are listed.—*Circle 503.

504. Parts Feeder

U. S. Engineering Co., 40-24 22*nd St., Long Island City* 1, *N. Y.*—4-*page pamphlet*—Features and applications of the Hoppermatic are covered in Brochure B-31. Typical feed rates for various screws, nuts, nails and other parts are given.—*Circle 504.

505. Industrial Television

Industrial Television Dept., Allen B. DuMont Laboratories Inc., 760 *Bloomfield Ave., Clifton, N. J.*—8 *page bulletin*—TV cameras and accessories, video monitors and accessories for industrial applications are described and illustrated. Models from line of lenses, cables and connectors are also shown.—*Circle 505.

506. Marking Machines

Geo. T. Schmidt, Inc., 4100 *N. Ravenswood Ave., Dept. A, Chicago* 13, *Ill.*—72 *page handbook*—Machines for marking different sizes and shapes of parts and equipment are illustrated in Catalog 14. Applications include marking of metal, plastic and wood parts with identifications, decorations or instructions.—*Circle 506.

507. Visualization Aids

Chart-Pak, Inc., Leeds, Mass.—22 *page handbook*—Book describes various charts and tapes in company line for constructing graphs, layouts for office or plant, data processing or work flow charts. Available templates are also shown.—*Circle 507.

508. Machine Tools

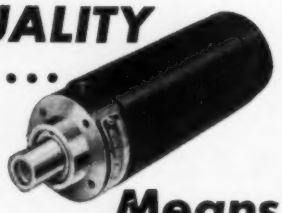
Consolidated Machine Tool Corp., Subsidiary of Farrel-Birmingham Co. Inc., Rochester 10, *N. Y.*—14 *page booklet*—Heavy duty machine tools for boring, turning, milling, planing and cold sawing are among machines described and illustrated in Catalog G-21. Several special purpose machines and locomotive and car shop tools are also illustrated.—*Circle 508.

509. Hinged Steel Belting

May-Fran Engineering Inc., 1761 *Clarkstone Rd., Cleveland* 12, *Ohio.*—6 *page pamphlet*—Five standard forms of hinged-steel belting are described, and diagrams, specifications and dimensions are included in Bulletin MF-600. Assembly instructions for the mass-produced interchangeable com-

*For Inquiry Card, see page 17

O-M Built-in QUALITY



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ponents, pre-engineered side chain and drive mechanisms are also given—*Circle 509.

510. Pointing Machines

Economy Engineering Co., Willoughby, Ohio—30 *page handbook*—Specifications, typical operations and production rates are given for 4 different automatic, hopper-fed pointing machines. Data and specifications on automatic shaving machines and thread rollers are also included.—*Circle 510.

511. Control Systems

Copes-Vulcan Div., Blaw-Knox Co., Erie, Pa.—12 *page booklet*—Operation of combustion, feedwater, feed-pump and soot-blowing control systems in a new powerhouse installation is explained in Bulletin 1032. A schematic diagram showing how the individual components are integrated into the system is included.—*Circle 511.

512. Magnetic Tape

Magnetic Products Div., Minnesota Mining & Mfg. Co., 900 *Fauquier Ave., St. Paul* 6, *Minn.*—8 *page bulletin*—Data on magnetic tape types for various instrumentation recording needs is given. Chart describing physical and magnetic properties for instrumentation use is included.—*Circle 512.

513. Fractional Motors

Bodine Electric Co., 2254 *W. Ohio St., Chicago* 12, *Ill.*—12 *page bulletin*—Single phase and 3 phase motors and speed reducers for fractional hp applications are among line of units described in Bulletin S. Dimensions and specifications are included.—*Circle 513.

514. Pressure Meters

Fischer & Porter Co., 99 *Jacksonville Rd., Hatboro, Pa.*—12 *page bulletin*—Instruments for measurement of absolute, gage or differential fluid pressures are described in Catalog 11-102. Operation and construction of units are illustrated and discussed and a chart giving standard ranges for linear scale cells is also included. Photo-pulse, resistance and digital transmitters for use with these meters are noted.—*Circle 514.

515. Air Line Devices

Arrow Tools Inc., 1900 *S. Kostner Ave., Chicago* 23, *Ill.*—16 *page booklet*—Data on filters, lubricators, regulators and drain traps for pneumatic lines is given. Performance charts on lubricators, regulators and filters and illustrations of various combinations available are included.—*Circle 515.

516. Overhead Cranes

Industrial Crane & Hoist, Ingersoll Products Div., Borg-Warner Corp., 1536 *S. Paulina St., Chicago* 8, *Ill.*—12 *page bulletin*—Construction of line of heavy overhead cranes is explained and illustrated in Bulletin HD-1000. Installation photos showing applications of the cranes in various industries are included.—*Circle 516.

517. Canvas Belting

Imperial Belting Co., 1750 *S. Kilbourn Ave., Chicago* 23, *Ill.*—4 *page pamphlet*—Duck belting for conveying, elevating, and power transmission in standard, oil-resisting, acid-resisting, moisture-resisting, heat resisting and sanitary types are discussed. Description of the belt construction is given.—*Circle 517.

518. Corrugated Boxes

Hinde & Dauch, Sandusky, Ohio—26 *page handbook*—Handling, packing and shipping of heavy products such as motors, pumps, and machine parts, in corrugated boxes are discussed in Catalog 12. Various styles of corrugated boxes, their advantages and features are explained—*Circle 518.

519. Hydraulic Valves

Commercial Shearing & Stamping Co., 1775 *Login Ave., Youngstown* 1, *Ohio*—92 *page handbook*—Data on directional control valves, other valve types, pumps and cylinders is included in illustrated Catalog H-12. Features and dimensions of the valves, and charts on performance ratings are given. Multicolor schematic diagrams illustrate flow paths. *Circle 519.

520. Roller Chain Drives

Acme Chain Corp., 420 *Dwight St., Holyoke, Mass.*—80 *page catalog*—Standard steel roller chains and attachments, heavy series chains, extended pitch chains and attachments, sprockets, and leaf chains are among drive components described in Catalog 5. Dimensions, capacities and prices are given, plus discussions of chain selection and chain drive factors.—*Circle 520.

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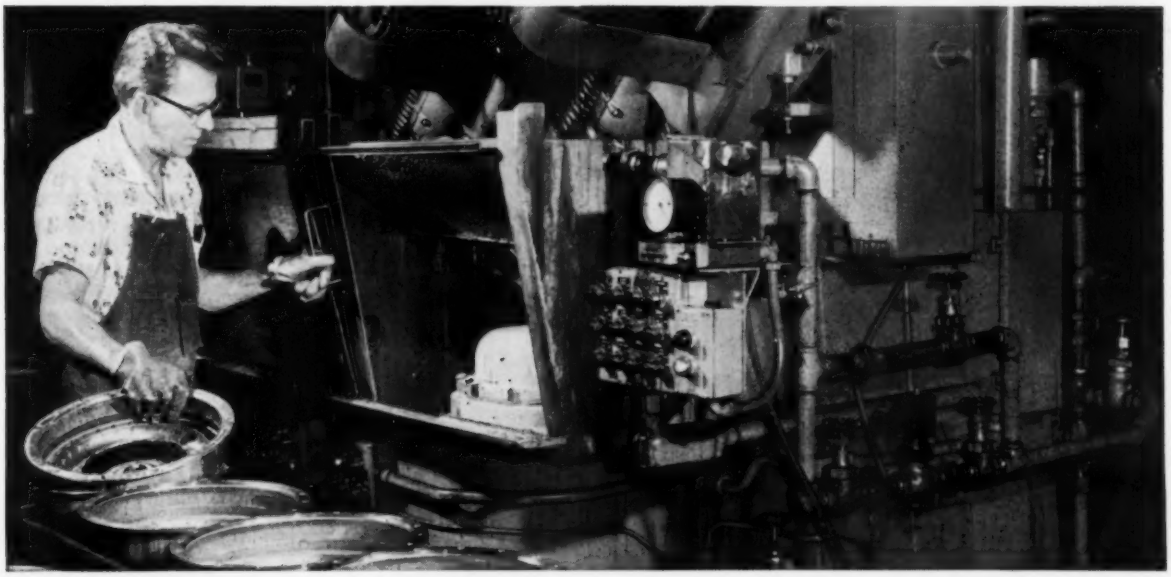

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521. Variable Speed Drives

Reeves Pulley Co., Div. of Reliance Electric & Engineering Co., Columbus, Ind.—24 *page catalog*—Operating features and installation photos of new design fractional hp Vari-speed units are given in Bulletin M-543-1. Remote and automatic control arrangements are noted. How to select units for a desired application is explained and prices and ratings are given for speed ranges from 2 to 1 up to 10 to 1.—*Circle 521.

522. Panel-mounted Instruments

Trio Laboratories Inc., 4025 *Merrick Rd., Seaford, N. Y.*—32 *page handbook*—Operation, mounting details and specifications of line of miniature, panel-mounting electronic instruments are described. Catalog also discusses the functional sections of the unit—amplifier, indicating meter, input range selector and power supply—and how they can be used in integrated systems.—*Circle 522.

523. Motor Control

General Purpose Control Dept., General Electric Co., Bloomington, Ill.—32 *page handbook*—Manual starters, magnetic starters, reduced-voltage starters, pushbuttons, relays and limit switches—their operation and application to control of industrial units are described in Catalog GEA-6372. Similar data on solenoids, vacuum, float and plugging switches, and pressure governors is included.—*Circle 523.

524. Wrapping Machines

Oliver Machinery Co., Grand Rapids 2, Mich.—6 *page pamphlet*—Packaging applications for a variety of products using cartons, trays, flat cards or no supports at all are described. Features of the wrapping unit and attachments for it are explained.—*Circle 524.

525. Flow Measurement/Control

Brooks Rotameter Co., Lansdale, Pa.—12 *page bulletin*—Features of rotameters for flow indication, recording, integration and control are discussed in Bulletin 115. Components of the units are described and installation methods are shown.—*Circle 525.

526. Pneumatic Handling

Fuller Co., Subsidiary of General American Transportation Corp., Cata-

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sauqua, Pa.—12 *page booklet*—Three types of company's systems—vacuum, pressure and a combination of vacuum and pressure as used in the pulp and paper industry are described. Applications and installations of systems are shown by photos and diagrams.—*Circle 526.

527. Controlled Volume Pumps

Milton Roy Co., 1300 *E. Mermaid Lane, Philadelphia* 18, *Pa.*—32 *page handbook*—Specifications and features of positive displacement pumps, designed for precise metering and pumping of corrosive liquids against pressure are given in Bulletin 553-1. Data and charts for materials selection and usage are also included.—*Circle 527.

528. Combustion Controls

Cleveland Fuel Equipment Co., 1111 *Brookpark Rd., Cleveland* 9, *Ohio*—16 *page booklet*—Application of systems engineering to combustion control is subject of booklet #1. Requirements and mechanics of draft control, interlocked controls and safety devices are explained and illustrated.—*Circle 528.

529. Conveyors

Metzgar Conveyor Co., Grand Rapids 4, *Mich.*—36 *page handbook*—Construction features and applications for gravity conveyors and power conveyors are described. Specifications for units and their accessories are included.—*Circle 529.

530. Nut Setting

Thor Power Tool Co., 1405 *W. Washington Blvd., Chicago* 7, *Ill.*—24 *page handbook*—Multiple nutsetters designed for automatic use on machine tools are included in line whose advantages and features are discussed. Basic questions and answers concerning application of nutsetters are given. Possible bolt spacings and patterns are noted.—*Circle 530.

531. Breadboard Components

Beckman/Helipot Corp., div., Beckman Instruments Inc., Newport Beach, Calif. — 24 *page handbook* — Description of components for breadboard assembly of gear trains and servomechanisms is given in Catalog 575. Data, photos and outline drawings of various components are included—*Circle 531.

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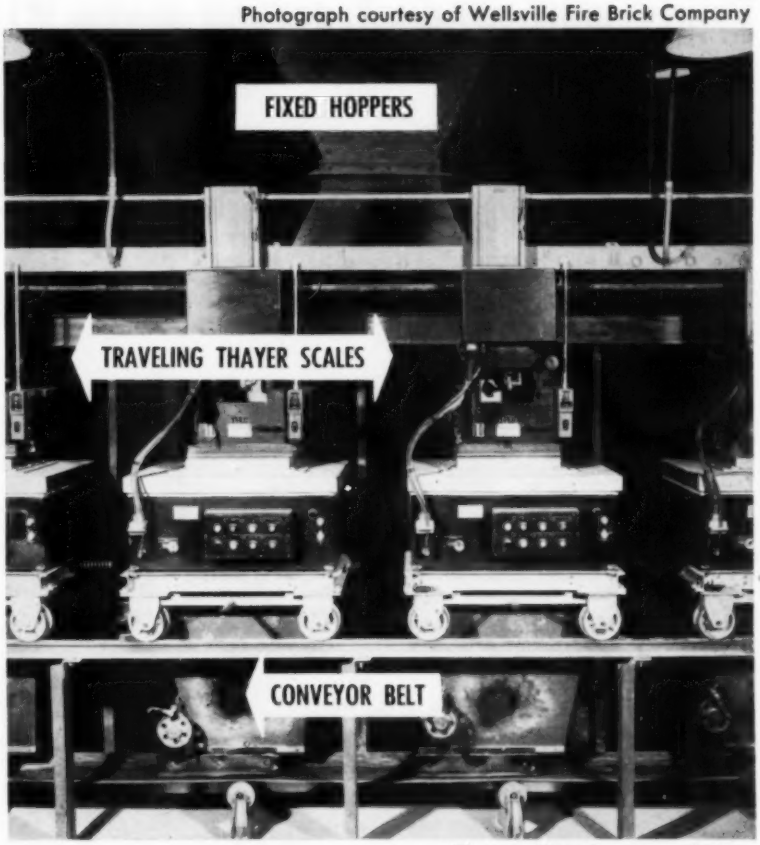
Photograph courtesy of Wellsville Fire Brick Company



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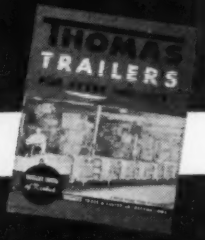

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532. Metalworking Machinery

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.—12 page booklet—Various models in company's line of cold heading equipment, wire mill equipment, power presses and rolling mill machinery are illustrated. —*Circle 532.

533. Hydraulic Equipment

Oil-Dyne Inc., 2115E W. Marquette Rd., Chicago 36, Ill.—52 page catalog —Technical data and specifications on numerous types and models of pumps, single and duplex pressure switches and hydraulic cylinders is given. Line of accessories including tube connectors, valves, hydraulic hose and fittings is described.—*Circle 533.

534. Liquid Metering

Hetherington & Berner Inc., 701-745 Kentucky Ave., Indianapolis 7, Ind. —12 page booklet—Operating principles of systems for direct control, remote control, dual valve and multivalve flow metering are described and illustrated in Bulletin FL-56. Installation photos are included.—*Circle 534.

535. Control Valves

C. B. Hunt & Son Inc., Salem, Ohio—12 page booklet—Construction features, operation and application of various air and hydraulic valves are described in Bulletin 571. Numerous illustrations are included. — *Circle 535.

536. Heat Treating Units

Ipsen Industries Inc., 715 S. Main St., Rockford, Ill.—4 page pamphlet —Automatic models suitable for carburizing, carbonitriding and hardening are described in Bulletin T-19A. Schematic drawing of a typical unit is included and specifications for single zone and double zone furnaces are given.—*Circle 536.

537. Speed Reducers

Cone-Drive Gears Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.—24 page handbook— Data on company line of speed reducers; and specifications for extended shaft and shaft mounted models are included in Bulletin CD-218. Tables of mechanical and thermal hp ratings, output torque ratings and chain pull ratings for numerous models are given. Detailed instructions for

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selecting a speed reducer are included.—*Circle 537.

538. Meter Relays

Assembly Products Inc., P. O. Box XX, Palm Springs, Calif.—12 page booklet—Operation and use of various meter relays are explained in Bulletin 104-A. A section devoted to miniaturized units describes the units and their applications.—*Circle 538.

539. Pneumatic Controllers

Moore Products Co., H & Lycoming Sts., Philadelphia 24, Pa.—18 page booklet—Principles of frictionless operation, pneumatic force-balance and remote-set installation of stack type controllers are discussed in Bulletin 5013. Features, sketches and dimensions of various units are given.—*Circle 539.

540. Industrial Trucks

Industrial Truck Div., Clark Equipment Co., Battle Creek, Mich.—16 page booklet—Line of fork-lift trucks, straddle carriers, powered hand trucks and towing tractors is described and shown. Specifications for each model are given and a section illustrating different attachments for fork trucks is included.—*Circle 540.

541. Weighing Systems

Morehouse Machine Co., 233 W. Market St., York, Pa.—12 page booklet—Proving rings, their use, operation and features for checking force measurement and weighing systems are described. Diagrams showing construction, and installation photos are included.—*Circle 541.

542. Resistance Welds

Taylor-Winfield Corp., Warren, Ohio —24 page handbook—Numerous products produced by resistance welding are described and illustrated in Bulletin SP-18. Projection, flash-butt, upset-butt, and seam welding are covered plus special applications in non-ferrous metals, stainless steel and aluminum.—*Circle 542.

543. Multicontact Relays

Phillips Control Corp., 59 W. Washington St., Joliet, Ill.—4 page bulletin —Data, features and characteristics of line of multicontact telephone type relays are given in bulletin. Photographs of enclosed or heremetically-sealed relays, and dimensional drawing are included.—*Circle 543.

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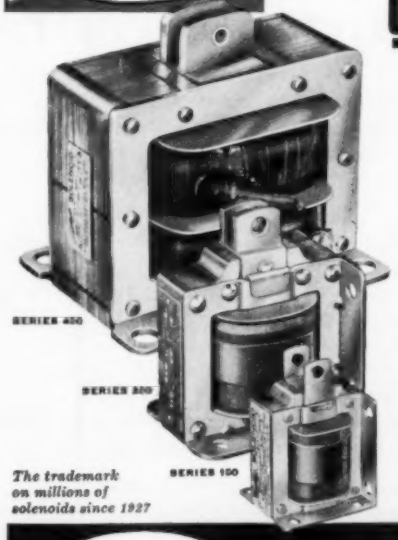

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Here G. D. Schott (right), Flight Controls Department head, discusses computer solutions of control and guidance problems with E. V. Stearns (center), Inertial Guidance Department head, and J. E. Sherman, Analog Computer Section head.

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PLANT RENEWAL AND REPLACEMENT

By C. W. GRIFFITHS
Chartered Accountant
Joseph Lucas Industries, Ltd.

AT ONE END of the scale the replacement and renewal of plant may be the type-for-type replacement of machines which have worn out, while at the other end it may refer to the major reorganization of a factory perhaps from batch production to line flow. In between these two extremes there are many kinds of replacements such as the reorganization of a group or line of machines; the installation of new machines of improved or different design; the introduction of special purpose machines to take over the operation of several conventional ones—for example, the modern transfer machine with its special feeds and ability to clamp rigid objects into precise register can perform all the operations of drilling, reaming, tapping, milling, shaping, honing, chamfering, spot-facing, and broaching. But whatever the scheme, the objective must always be the same—to reduce machining and handling time. The whole animation and expansion of an organization depends on this drive to save time; unless this is actively pursued and encouraged stagnation will result.

Within the general framework of the drive to reduce machining and handling time, the immediate causes for plant replacement fall into three straightforward groups: (1) Wear and tear, where machines are physically worn out and cause breakdowns, poor quality and scrap, excessive maintenance and premature overhauls; (2) Obsolescence of machines, where improvements in new machines make earlier models obsolete and uneconomic by comparison; and (3) Obsolescence of methods, where new manufacturing processes such as high-frequency heating, new materials (as, for example, the new magnetic materials, semiconductors, etc.), or changes in product design offer savings in cost, but require new or different machine tools. In addition, it cannot be overlooked that human factors also play their part; the health and safety of operators, the skill and effort called for, labor's reaction to new methods, are all considerations to be taken into account. In selecting plant to meet these needs, it will be seen that a wealth of technical and statistical data may be brought together to support the rival merits of different types of machines and methods—but the final decision will usually, and rightly, depend on the engineer's own judgment and experience.

The various ways in which savings may be expected from these replacements can be similarly classified. They fall into two main groups; those which are specific to a particular machine or operation (or group of machines or operations) and are directly calculable; and those which are consequential, carrying indirect benefits into all aspects of manufacturing cost. Consequential savings arise particularly in connection with large-scale reorganization schemes.

Specific Savings

There can be only a limited class of work for which it is worthwhile to keep plant until it is finally worn out. Except for operations of the lowest engineering standard it generally pays to replace a machine long before it is physically exhausted. The economic life of plant may be determined by the rising costs of maintenance and overhauls, by improvements in the design of new machines, or by changes in manufacturing methods. As a result of the progressive development of new materials and new techniques, the economic life of plant in the larger mass-production factories is steadily diminishing.

Specific savings offered by new plant arise in a number of ways. Maintenance and overhaul expenses are an obvious example, and these are discussed in more detail later: As with an old car, so with an old piece of plant, the older it grows the higher the repair bills until the day comes when it is cheaper to replace than to continue repairing. Frequently, however, before repair costs become a deciding factor, improvements in the design of new plant offer operating economies that justify a change. This *betterment factor* as it is called, involving perhaps an increase in the range of speeds or adaptability of a machine, may enable fewer new machines to do the work of the old ones. Such improvements, whether materializing gradually over the years or quickly, inevitably render earlier models obsolete and uneconomic by comparison.

Overshadowing both repair costs and the *betterment factor,* improvements in product design and manufacturing methods frequently offer decisive economies although involving different or even special-purpose plant. This field offers the greatest scope for improved productivity and economy and a fair measure of a company's engineering initiative might be found by comparing the proportion of replacement machines required for new and improved processes with the proportion of type-for-type replacements. The above three basic reasons for replacement all depend for their validity on the savings offered. It

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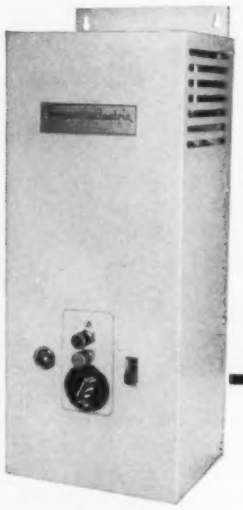

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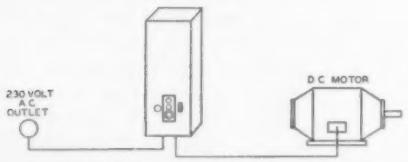

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follows that these savings should be carefully investigated and fully documented.

So far plant replacement has been considered as it affects individual machines or small groups or lines of machines, but it sometimes happens that consideration has to be given to far-reaching changes as part of a large-scale reorganization of manufacturing methods. This may come about either because future output requirements of the product in question are beyond the capacity of existing plant, or perhaps because marketing results are unsatisfactory and drastic action of some kind is needed to improve quality or to reduce costs.

Program Review

The first essential is to stand back and take a view of the business as a whole. The only possible approach to such a problem is a definite plan of campaign to insure the logical investigation of all factors in their right sequence, so that each stage of the inquiry will benefit from previous findings. First, what is the sales policy? Next, the question of product design to suit that sales policy. Both these stages require economic guidance, and this means the third step of providing time and cost data. Armed with knowledge of sales policy, product design, machining or operator times and product costs, the fourth step, that of factory problems, can be investigated and the solutions sought. Finally, with answers under all four headings, it is possible to draw up an objective selling price and cost statement showing how the gross margin can be secured. Only then will it be possible to form a sound judgment as to the machines required. It will be as well to say a few words about each of these stages in turn.

The reason for studying the sales policy is to determine as nearly as possible the future requirements of the product in terms of quantities per month or per year, a clear view of the volume of output being an obvious essential; also to be satisfied as to the stability of the product in its present general form, in order to guard against making long-term plans for the production of something which the trend of market conditions may perhaps radically alter in the near future. There will be a host of questions to be asked and answered, relating particularly to the range of products and quantities required, standard and non-standard types and comparisons with competitive products.

Following immediately upon the examination of sales policy, product designs need reviewing to meet any changes dictated by latest thinking on sales policy. For instance, does the existing design permit the maximum benefit to be obtained from specialization; simplification; and standardization? In certain types of business, the most effective road to standardization is by closer working with the customer, and by the steady pressure of price differentials for standard and non-standard products. In this field, no useful progress can be made unless the sales people clearly understand the real meaning of standard and non-standard lines in terms of factory problems, and realize that the responsibility for furthering the company's policy rests almost entirely upon them. In

Circle 728 on Inquiry Card

their relations with the customer, in the personal pressure they exercise, and in the price structure they fix, they can work with the factory people towards a common goal. The material content of the product will come in for close examination at this stage, both in relation to standardization and also in connection with alternative types or specifications of material, which may perhaps be cheaper to buy or easier to process, or may better suit the types of plant already available.

In considering matters of sales policy and product design, it will be important to be able to draw on reliable product cost data, so that sound economic guidance can be obtained. Dependable time and cost data will be vital when the fourth stage is reached of investigating possible economies in the factory. It will be equally important at the fifth and final stage of preparing an objective sales and cost statement. While the first two stages are in progress, all manufacturing layouts and other basic documents giving details of current manufacturing times and costs will be checked to insure their accuracy.

Having the latest and best information on sales policy, design policy and product times and costs, it is now possible to take the fourth step of studying factory problems. Product quality involves questions as to scrap, rectification, machining tolerances, inspection, and quality control, all of which must be answered before a start can be made on determining what are the best types of plant and tools for the job. A study of factory capacity in terms of floor space, machine tools, equipment and people, to determine their ability to deal with the required quantities and types at the required times; and a review of all purchased components and subcontracted work should be undertaken at this time. Comparisons of productivity with others engaged in a similar field may usefully cover not only direct machining or floor-to-floor times, but also the ratio between total outputs and the total number of people engaged in production.

On the basis of the estimate of future requirements, of the final designs and specifications, and of the proposed manufacturing methods and times, a statement can be drawn up showing the sales revenue to be expected, the manufacturing and other costs to be met and the resultant profit margin.

Indirect Savings

In a large-scale reorganization scheme, in addition to specific savings on particular operations, a wide range of consequential savings will also be looked for. It will be useful, therefore, to comment briefly on the various ways in which these consequential savings arise. A quicker flow of work through the production stages will bring about significant reductions in stocks of work-in-progress on the floor of the shops and in component and subassembly stores. In consequence, cash previously tied up in stocks will be freed for other uses; space previously occupied by stocks and stores will be released for productive purposes; laborers, storemen and checkers, previously employed in picking up, putting down and counting, will be freed for more useful work; and progress

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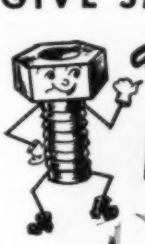

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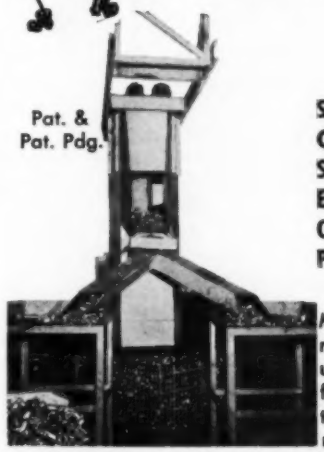

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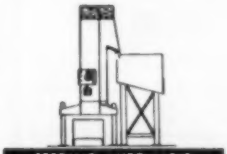

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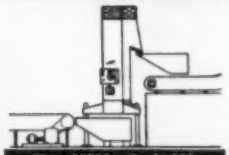

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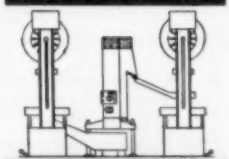

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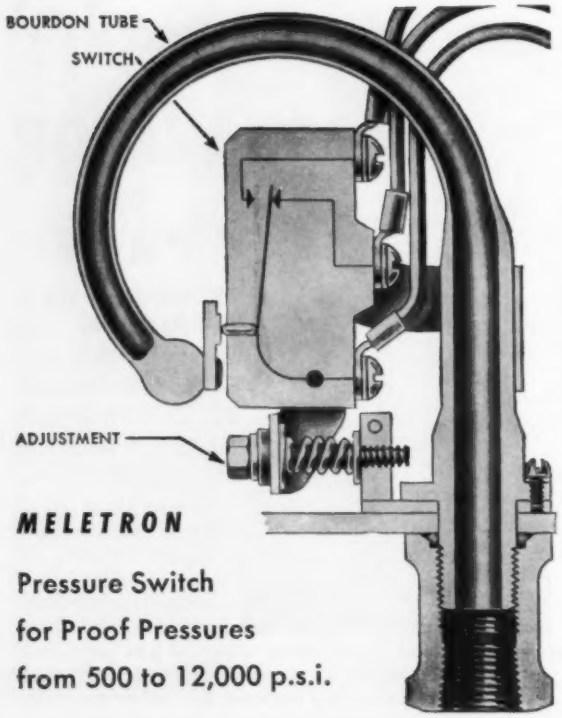

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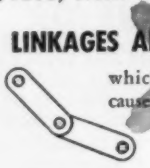

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Following standardization and the reduction of a multiplicity of different components to a compact range of standard parts, the longer machine runs will require fewer machines and equally, of course, fewer kinds of machines. Here again, stocks will benefit from the reduced range of components, and even machine-tool spares and plant maintenance will be simplified by standardization of machine types. Another form of space-saving may arise when, for instance, an extension to a shop or bay is being considered to provide for additional machines. A case in point occurred where a small business required a 50 per cent increase in output; there were 10 automatics which entirely filled the shop and it was proposed to build an extension to house 5 more of the same type. Investigation showed, however, that 8 machines of another type would provide the same output as 15 of the existing make, and could be fitted into the space occupied by the 10. Instead, therefore, of buying 5 additional machines as originally intended, it was found cheaper to sell the 10 already in use and replace with 8 machines of another type: and no building extension was needed.

Plant Utilization

The utilization of plant is a subject in itself and reference can be made here only to those aspects that bear directly on the economies of plant replacement. It is surprising how few factory managements in fact really acquaint themselves with the precise rates of utilization at which their plant is working. It is even more surprising in view of the comparative simplicity with which these rates can be established. The ways in which utilization rates may assist in replacement problems and supplement the judgment of engineers are many and various: (1) It is clear that the higher the utilization rate the sooner will a machine pay for its replacement by an up-to-date model embodying the latest modifications and improvements, (2) the utilization rate of each type of machine may usefully be shown as a regular item of information on all applications for the purchase of plant, so that any tendency towards the routine replacement of worn-out machines may be suppressed unless the workload on the remaining plant justifies a new one. This is important in view of the progressive improvements in plant design, which often enable the same work to be accomplished with fewer machines; (3) in problems concerning the interdependence of machine and labor utilization, economic guidance is useful to show which offers the greater reward as a result of improvement, if a choice has to be made between them. As machine tools become more and more specialized and expensive, and hourly depreciation rates soar above hourly labor rates, the sight of an idle machine should provoke in the factory manager as strong a reaction as the sight of an idle man; (4) the calculation, in advance of purchase, of the probable utilization of new plant will be vital to economic selection between standard and special-purpose machines; and (5) statistics provide vital information as to the machine-hour require-

ments of the manufacturing plan and the prospective load on each type of machine. The light this sheds on future plant requirements deserves further explanation.

To determine the future level of plant requirements, particularly with reference to the planning of replacement programs and additional capacity, it is necessary to know the relationship between the present machining capacity of the factory and the machining requirements of the manufacturing plan based on sales. The former is easily established, the hours available for each type of machine being simply the number of machines of each type multiplied by the shift hours. On the other hand the machining hours required by the manufacturing plan are less easily calculated, the main difficulty being the amount of detailed work involved in the calculations, namely, the breakdown of the component quantities into machine hours required for each operation, and the grouping together of these machine hours by types of machine. In many factories there will be a standard time allowed for each operation, but it is a task of some magnitude to work it all out to arrive at the total standard hours called for on each type of machine. Even then the answer is in standard hours, and has to be qualified by average operator performance to arrive at the actual hours likely to be needed, comparable with the actual hours available. In contrast to these involved and laborious calculations, utilization returns show the machine hours in fact being worked by each type of machine, and thus, to the extent to which the manufacturing plan is being achieved, represent the machining requirements of the manufacturing plan. No information could be more relevent than this to support the need for either replacement or additional plant.

Maintenance

Engineers have no doubts as to the relevance of maintenance to the economics of plant renewals. Effective maintenance keeps machines running accurately and efficiently, postponing the onset of wear and tear and the need for replacement. Lack of maintenance causes breakdowns and stoppages, poor quality work, excessive scrap and operator dissatisfaction, provoking demands for replacements or premature overhaul. Good records of maintenance work will be found valuable, particularly as machines grow older, to show when repairs have risen to an uneconomic level, and will also reveal interesting comparisons between the respective maintenance costs of similar machines of competitive make which may well influence replacement policy. Effective maintenance means planned and systematic maintenance, in other words, a preventive maintenance scheme.

In a factory where plant records have been properly kept, there will be found to be a build-up over the years of vital information bearing on the operating costs of the plant in use. Perhaps the simplest way to illustrate the practical use to which recorded information can be put is by reference to a particular

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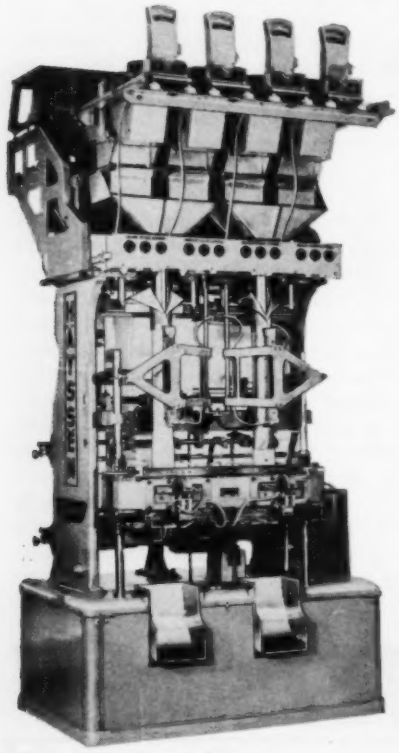

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investigation into maintenance and overhaul expenses: A factory had a multispindle automatic shop of 48 machines and this shop was the scene of endless breakdowns and stoppages. When the problem was logically investigated the first significant point noted was that of the 48 machines, 35 were all of one make, type A, and the remaining 13 were of a heavier and more expensive make, type B. It was decided, therefore, as a first step to measure the comparative performance of the two types of machine to see if this would open up a useful line of investigation. Fortunately, the maintenance records had been well kept, and it was possible to analyze the hours lost as a result of machine breakdowns by each type during the previous five years, TABLE 1. As shown, the type A machines each lost on the average 195 hours a year, while type B lost only 117, confirming to the investigators that they were on the right lines in examining the comparative performance of the two types of machine. In pursuing this comparison, the second stage of the inquiry was to measure these lost hours by age groups; this showed that the lost hours of type A increased very rapidly in their fifth or sixth year to the point at which overhauls became imperative, whereas type B machines maintained an acceptable trend until at least their tenth year. The trends are shown in *Fig.* 1. The picture that finally emerged from these investigations was that the type A machines had to be overhauled every five or six years, the type B machines endured ten or eleven years between overhauls, and the question naturally arose whether it would not be better to replace all the type A machines with type B. Moreover, it was found that owing to excessive time lost in the past and also allowing for improvements in the latest type of machine, only 28 type B machines would be needed to replace the 35 existing type A. The cost of these 28 new machines was found to be actually less than the money that was being spent on overhauling the existing machines.

There are companies engaged in high-precision engineering work who claim that it is more economic to replace certain types of plant, for instance automatics, with new ones before the first overhaul becomes due. This thinking is comparable with that of the motorist who reckons to sell his car after 20,000 miles of trouble-free motoring and to buy a new

Table 1—Maintenance Records for Two Machines

Cause of breakdown	Average lost hours due to machine breakdown per machine per year	
	Type A	Type B
Motor	2	4
Electrical faults	2	6
Clutches	31	19
Broken stop pin	11	..
Longitudinal motion	2	..
Center block and independent slides	7	..
Cross-slide mechanism	10	10
Indexing and bar feeding	30	9
Radial stops	3	1
Spindles and bearings	32	17
Lubrication	1	3
Coolant System	8	3
Feed gears, shafts, etc.	3	..
Locking shoes	4	5
Carrier brackets, etc.	5	6
Collet opening and closing mechanism	5	13
Attachments	8	4
Bolts	1	..
Main cams	..	2
Bar stops	..	2
Brake	..	2
Miscellaneous	30	11
Total	195	117

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one before the trouble starts. He hopes never to pay a bill for repairs and never to have his car out of action. The validity of the argument depends to a great extent on the prices ruling for secondhand values and for reconditioning, and these will inevitably vary with circumstances. The point to be borne in mind, however, is that provided the total cost of replacing with new machines comes out near enough to the cost of overhauling, then the additional advantages of replacing with new machines are secured for nothing, namely: The improvements in design and performance that are continually being made in new plant are brought into effect much sooner; and there is no loss of production while a machine is being overhauled.

Good recording procedures are vital in a factory of any size to insure that reliable information is available for the examination which has to be carried out before machines are replaced. An effective system of coding, for example, has a definite influence in deciding the numbers and types of machine required. A code should be designed not only to identify the finished product and the different finishes and fittings, but also the various materials from which the parts are made and so on. The setting up of a code opens up the whole question of standardization which, if expedient and practicable, is one of the surest methods of reducing costs. This reduction in variety and the resulting increase in the flow of work will have a great bearing on the design, the number and type of machine ultimately used and on the general economy. A suitably designed code can also be used

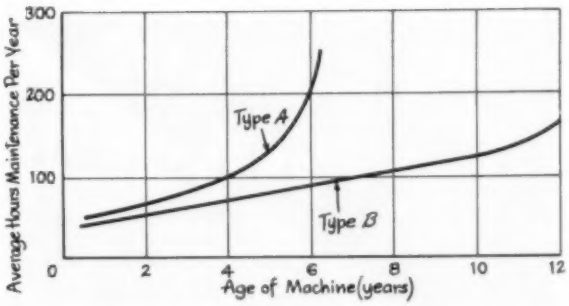

Fig. 1—Comparison of maintenance required for two types of multispindle automatic machines.

to co-ordinate the requirements of different departments, as for example the drawing office, buying office, manufacturing planning office, and will reduce the machine and material requirements, work in progress and finished stocks, and even the day-to-day routine clerical work.

Another important record which might be mentioned is the operation layout. In a factory where this has not been looked into, most of the official manufacturing layouts will be found to be incorrect and not worked to by the operators. A detailed check will show wide discrepancies between what the operators are actually doing and what the management thinks they are doing, owing to a variety of reasons. Operators find for themselves quicker methods which are not notified back to the office, they also use

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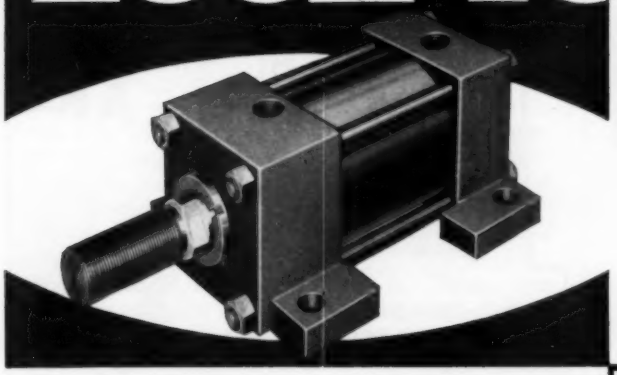

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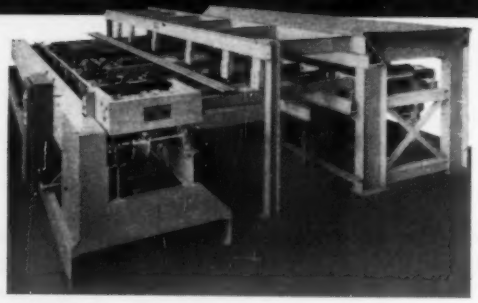

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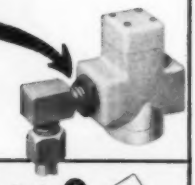

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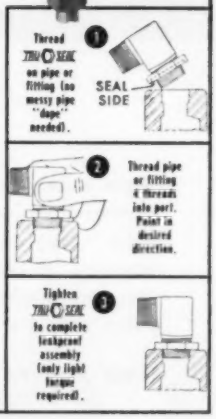
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alternative machines and alternative tools without considering the question of cost, and these methods can eventually become recognized as the standard if not watched.

It is important to be able to supplement the visual scrutiny of plant with the much wider information available from a sound and up-to-date set of plant records. However small a business may be, it is necessary at some stage to refer to records showing when a machine was purchased; its cost; and its history, and the greater the number of machines the more comprehensive and systematic these records should be to give a complete picture. Broadly speaking there should be a plant record card available for every item of equipment showing: Some means of rapid identification, usually a serial number, together with details of its location and all movements and transfers; technical data covering the whole life of the machine; a full description, name and address of supplier, date and cost of purchase, classification, date of inventory check, full details and costs of additions, repairs and maintenance. It may be desirable to show on separate data sheets the detailed specifications and drawings where applicable, the progress of maintenance programs, hours operated, breakdowns and hours lost, etc. Financial information as to original cost and book values, depreciation rates and taxation allowances, replacement values, etc., is also usually kept in a separate record. The ideal arrangement is for a mechanical procedure to be available, so that rapid analysis of this information can be made under the widest variety of headings which avoids much listing and physical inspection of the machines concerned.

As regards the actual ordering, rather than let the general buying department handle this it is advisable to keep it away from the routine buying and, in a large organization, to have a central plant purchasing section, staffed by a qualified engineer or engineers acting in a specialist or advisory capacity, responsible for keeping up-to-date with the latest changes in plant design over the widest field both at home and overseas. This engineer will also be in close touch with the machine-tool manufacturers and be familiar with what is available and when.

The accountant is responsible for the sanctioning procedure and for seeing that all expenditure has been duly authorized. He keeps an eye on the ordering and purchasing generally; for example, he sees that worn out or obsolete machines are withdrawn when replaced by new ones (if not watched the factory will keep the old ones as well); that plant is not used for a purpose other than that sanctioned, or moved to another location without authority; that all disposals of plant are satisfactorily dealt with, preferably by the plant purchasing section; and that transfers of plant from one factory to another within a company or group are properly handled. He is responsible for the recording procedures generally.

Depreciation Policy

To have the cash ready to pay for the replacement of plant depends to a large extent on the depreciation policy adopted. The object of the depreciation policy

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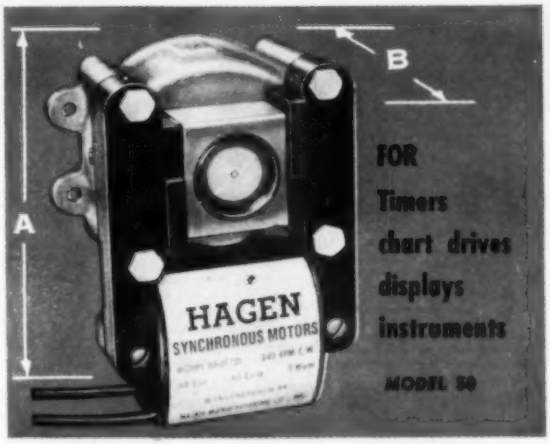

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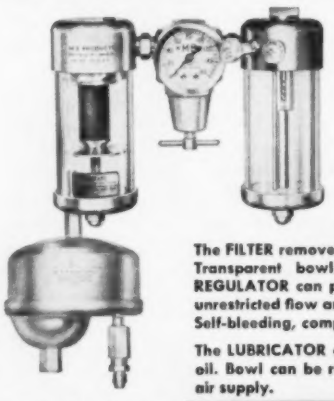

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is to insure that sufficient funds are recovered in selling prices and set aside year by year to make good the diminishing value of the plant, while at the same time there must be no question of overcharging. Depreciation is a growing element in the cost of manufacture and in many cases exceeds the direct labor cost. Every prudent businessman knows that during times of inflation it is not sufficient to recover only the original cost of the plant because this will fall a long way short of the sum required for its replacement. Only a realistic depreciation policy will preserve the physical investment in plant from shrinking. It is apparent that under present conditions the ultimate replacement cost of plant cannot be known in advance, and the only practicable system is to base each annual depreciation charge on the prices actually ruling year by year. Even then, unless the rate of replacement is steady from year to year, the amount provided will fall short of requirements.

An attempt has been made in this paper to draw attention to the principal factors bearing upon the economics of plant renewals. It will have been seen that no simple formula exists, or is ever likely to exist, to replace the judgment and experience of engineers, and that however many statistical data are adduced in support of plant selection, the imponderables remain imponderable. The future trend of product designs; pending changes in material forming techniques; the development of feedback controls and automatic gauging; the intangible benefits associated with an improved flow of work; these and many other problems present a continuing challenge to our foresight and imagination.

From the many topics touched upon in this paper, and despite their conflicting nature, it is suggested that three main conclusions may usefully be drawn: First, with the ever-increasing rate of technological progress in machine tool design, in the improvement of production methods, and above all in the development of new materials and processes, the type-for-type replacement of plant on an age or wear-and-tear basis is steadily giving way to replacement by improved or different machines which are able to reduce machining or handling times. The advantages and savings to be derived from the higher productivity of these new machines progressively justify the displacement of machines which may still be serviceable but technically obsolete. Second, this displacement of age by other economic factors must be fully and faithfully reflected in depreciation policy, to guard as carefully as possible against losses arising from obsolescence; and responsibility for bringing this to notice must rest largely with engineers. Third, if adequate funds are to be provided for the replacement of plant at ever shorter intervals, higher rates of utilization become increasingly important. As the span of life of a machine diminishes in years, so must its effectiveness increase; on our ability to get more production out of plant in a shorter time the economic future of our manufacturing industries may well depend.

From a paper entitled "The Economics of Plant Renewal and Replacement" presented at a General Meeting of the Institution of Mechanical Engineers, London, Mar. 1957.

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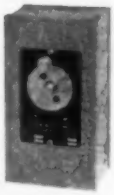

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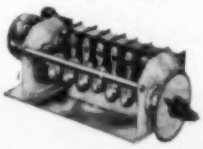

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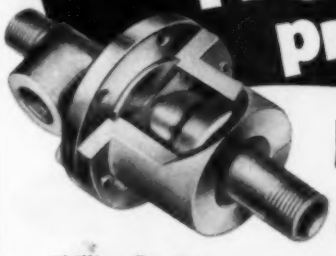

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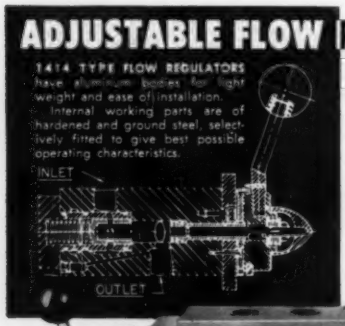
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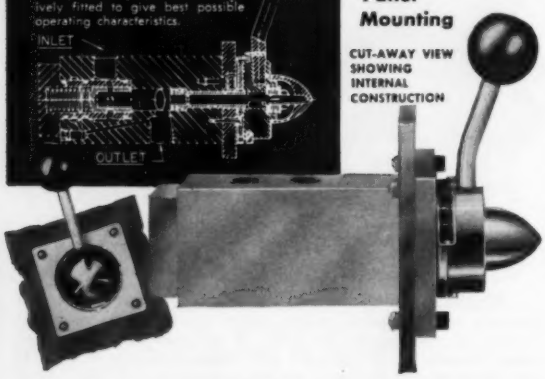

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AUTOMATION patents

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DEVICE FOR CONVERTING ROTARY MOTION INTO RECIPROCATING MOTION OR CONVERSELY

Magnetic poles on the face of a rotating member alternately attract and repel similar magnetic poles on the face of a nonrotating reciprocating member. Patent 2,790,095 by Johannes J. A. Peek and Johannes M. Cluwen, assigned to North American Philips Co. Inc.

MAGNETIC STACKING MECHANISM

Magnetizable articles such as can lids are stacked in an elongated hopper under the control of magnets around the hopper. Fields of the magnets continuously link with the moving articles, maintain them in parallelism, and control their uninterrupted and retarded travel to the bottom of the hopper. Patent 2,795,340 by William B. Hommel, assigned to American Can Co.

METHOD OF AUTOMATICALLY CONTROLLING THE OUTPUT OF A CARDING ENGINE

Variations in the weight per unit area of a web of material are assessed during its passage through a process by passing a beam of light through the web and sensing variations in light transmitted. Relative speeds of successive process elements are then controlled to produce a substantially uniform web. Patent 2,795,012 by Robert Gibson, Gordon H. Thorndike and Charles Liversidge, assigned to Wool Industries Research Association, Leeds, England.

PERFORATED MEMBER SENSING MECHANISMS

Perforations in a record member are sensed by a flexible conductive diaphragm which contacts appropriately spaced conductive members arranged on the opposite side of the record member. Patent 2,796,476 by Charles F. West, assigned to Soroban Engineering Inc.

LIQUID LEVEL CONTROL

Level of liquid in a tank is controlled by selective actuation of pumps supplying the tank. Tank level is sensed in a vertical chamber containing liquid isolated from liquid in the tank but responsive to its level because of a flexible diaphragm between the two chambers. Patent 2,797,702 by Raymond G. Martin.

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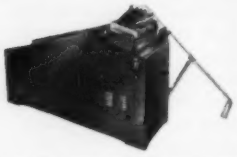

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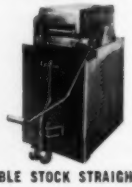

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By William D. Bell, consultant on electronic data processing, Mellonics, 403 pages, 6 by 9 inches, illustrated, clothbound, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; $6.50 *postpaid.*

Written primarily for executives, this book provides general information on the functioning, state of development, selection and applications of electronic computers for business use. Programing techniques are illustrated and a two-stage evaluation approach which begins with a preliminary survey and leads to a final recommendation report is outlined. The last part of the book contains eleven case histories of computer usage for business applications including actuarial operations, accounting, production scheduling, inventory control and management reporting.

Association Publications

TRANSACTIONS OF THE ELEVENTH ANNUAL CONVENTION OF THE AMERICAN SOCIETY FOR QUALITY CONTROL

Paperbound, 156 pages, 6 by 9 inches, illustrated; available from American Society for Quality Control Inc., 161 West Wisconsin Ave., Milwaukee 3, Wis.; $3.50 *postpaid.*

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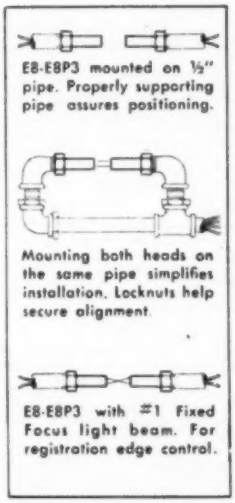
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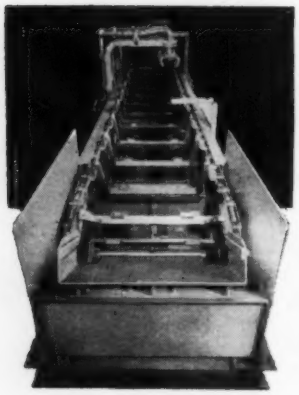
AUTOMATION COMPONENTS



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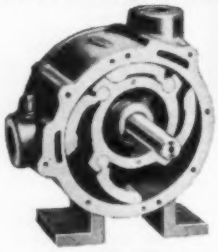
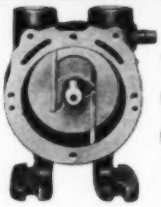


VACUUM —up to 29.9" Hg.
PRESSURE —up to 20 psig.



2 WING TYPE
Vacuums -to 29.9" Hg.
Pressures -to 20 psig.
Displacement -to 40.8 c. f. m.

4 WING TYPE
Vacuums to 20" Hg. Pressures to 15 psig. Displacement to 162 c. f. m.

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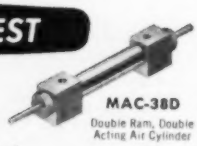

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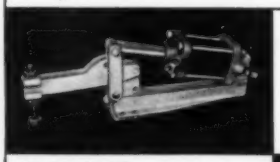

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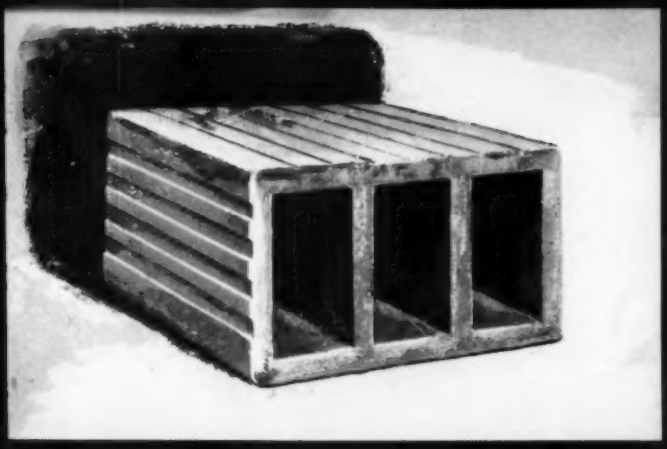

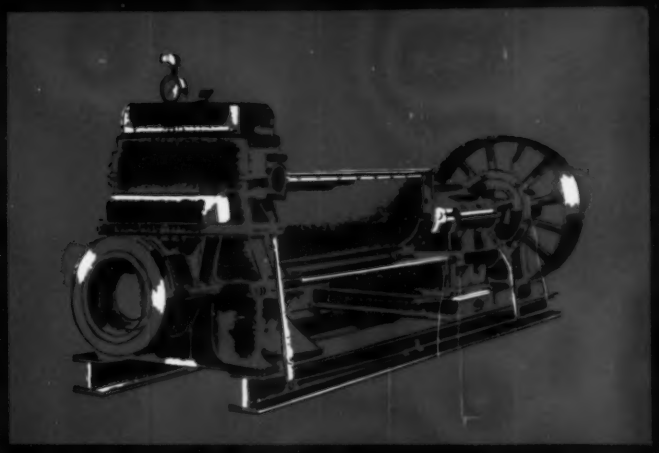

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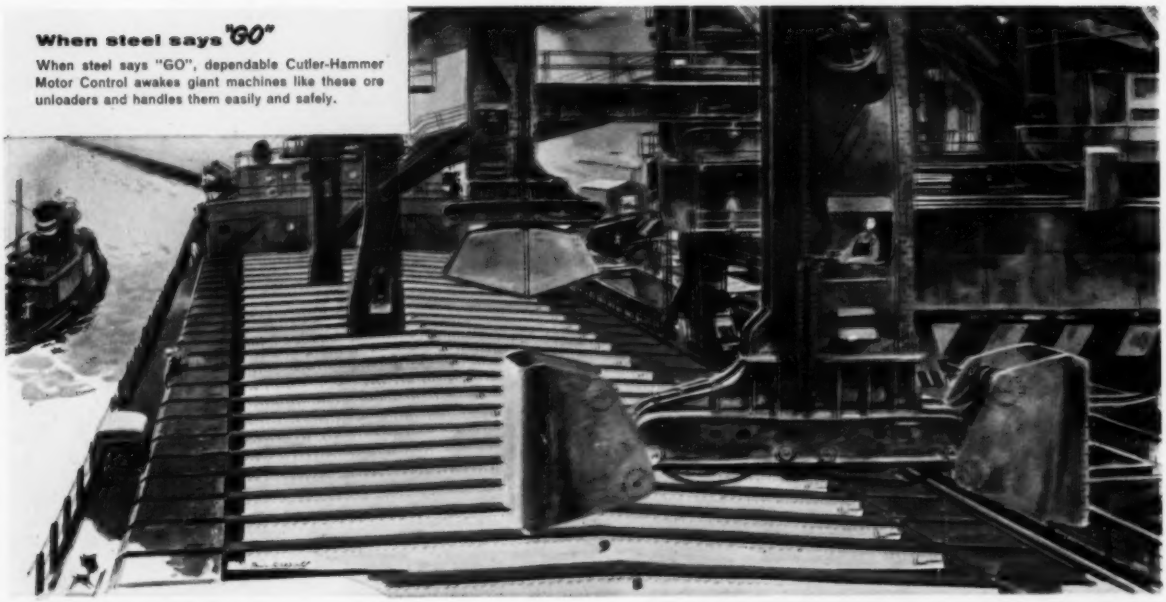

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